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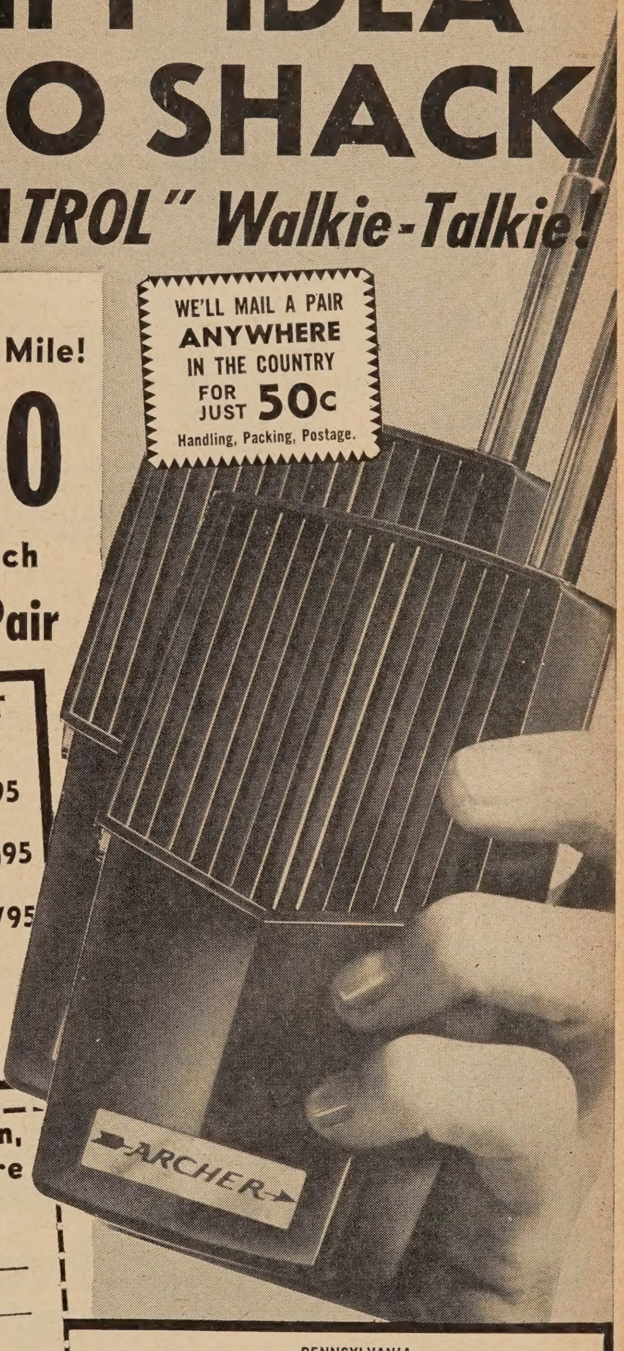

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DECEMBER 1964 VOL. XXXV No. 12

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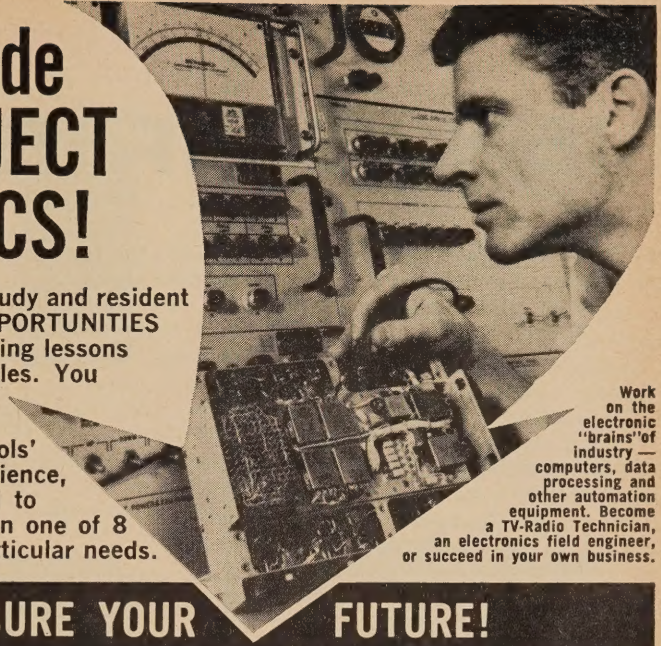

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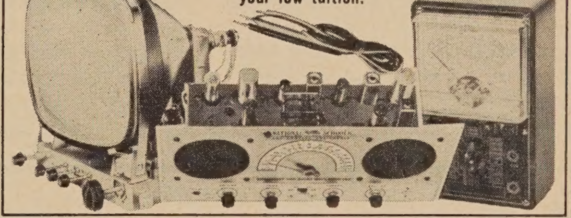

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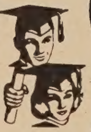

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NEWS BRIEFS

ELECTRONIC SWITCHING SYSTEM FOR FUTURE TELEPHONES

An electronic telephone-switching system will soon begin to replace present electromechanical systems in Bell Telephone offices, according to a report by Bell Telephone Labs and Western Electric engineers to a gathering of the press at Holmdel, N.J. The new system will offer a variety of telephone services not usually possible with the present systems. Among the advantages will be:

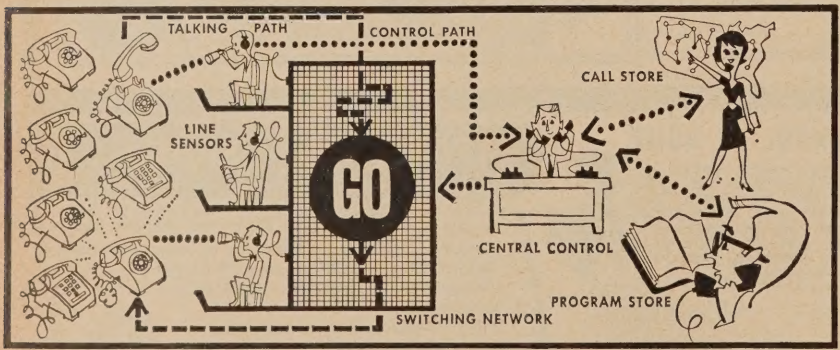
Abbreviated dialing, by which frequently called numbers can be reached by dialing an abbreviated two- to four-digit call instead of the regular long one.

Call transfer, which means that a person can dial a code and then the number of a nearby telephone. This will cause all his incoming calls to be transferred to that telephone.

Also available will be a signal which will tell a person telephoning that another call is trying to get through.

These, and other services now not even thought of, may be possible because the new technique uses a *program control* system of magnetic memories. Instructions for providing services and processing telephone calls can be modified or removed and new ones added by simply removing memory cards and "rewriting" the information on them. In today's system it would probably be necessary to rewire systems to provide additional services.

The electronic switching system will begin operation shortly in Succasunna, N.J., followed by electronic central offices on a limited basis in New York City, Washington, D.C., and Norfolk, Va. All new offices will use the electronic switching system, and equipment will be replaced gradually in existing offices.



The new system reduced to pictures. Line sensors scan all phones served by the office every tenth of a second, detect a call for service when phone is lifted off hook, alert the executive section (central electronic control), which goes into the program store to set up the call, passes the command to the switching network, and the talking path is completed (to the lower telephone). Central control is a computer which uses approximately 30,000 transistors and 45,000 diodes. It works with two memories, program store and the call store. The program store is a semipermanent magnetic memory that contains all long-term instructions (such as how to set up call transfers, etc.) The call store is a short-term memory which would be used, for example, for data having to do with a particular call.

NEW YORK HI-FI MUSIC SHOW: TRANSISTORS GAIN GROUND

Despite fears of a decline in component audio sales, some 22,000 persons visited New York City's Institute of High Fidelity Show during the 4-day exposition from Oct. 1 to 4. There was no evidence of a shrinking component market, though packaged systems—consoles and portable phonos—were far more numerous than in 1963.

Transistors again stole the show in most of the rooms. Electro-Voice, just before the official opening, showed a new line of all-transistor components with which they are re-entering the hi-fi component field after several years' absence. Harman-Kardon will produce only all-transistor equipment from now on, gradually abandoning its tube components. Most others have at least a partly transistorized line (that is, units that are partly transistor, or transistor units as part of the line), except for two major manufacturers, Marantz and Dyna.

As one of the show's special features, a forum of four chief engineers from four companies argued the merits of transistors tubes for audio outputs. Represented were Robert Furst of Harman-Kardon (all-transistor): Fred Mergner of Fisher and Victor Brociner of H. H. Scott (middle-of-the-road) and David Hafler of Dyna, who feels strongly that transistor audio equipment is not yet sufficiently good to warrant such excitement.

Another highlight of the show was a tone arm designed to track linearly along the radius of the record, with absolutely zero tracking error. Introduced by Marantz, it is part of a complete turntable–tone-arm–cartridge system expected to sell for about $300.

NEW VIDEO RECORDERS AT INTERMEDIATE PRICES

Two video tape recorders recently demonstrated fall pricewise between the professional type, which runs from $12,000 up, and the promised home recorders demonstrated by the late Telcan, and by Fairchild and Par-Vision, expected to sell at $500 or less.

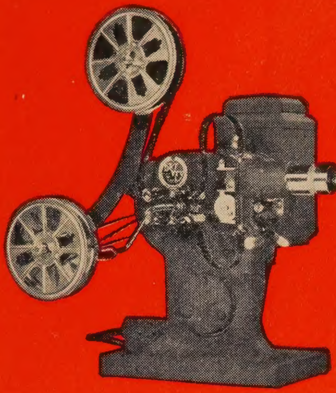
One of the two new machines is made by Loewe-Opta of Germany. Its weight is 40 lb, its price $2,500 and the resolution 3 megacycles. The tape speed is 6 inches per second. Pictures were said not to differ greatly from those made by the more expensive tape recorders.

The second machine, handled by North American Philips, is produced by a Philips affiliate in Vienna. The tape speed is 7.5 inches per second, resolution 2.5 megacycles, weight 98 lb, and expected price about $3,000.

AUTOMATIC BOOK COMPOSITION

A computer program called ROCAPPI (for Research on Computer Applications in the Printing and Publishing Industries) arranges books on a line-for-line basis, making all corrections and alterations in copy and format before the final output tape is produced for activating a typesetting device. It "will virtually eliminate the tedious chores in the composing room incident to production," according to John W. Seybold, president of ROCAPPI.

Using the RCA 301, the system stores the book manuscript on magnetic tape and will process a 300-page book in about three hours, a job that would normally take a printer nearly a month, working 12 hours a day, 6 days a week.



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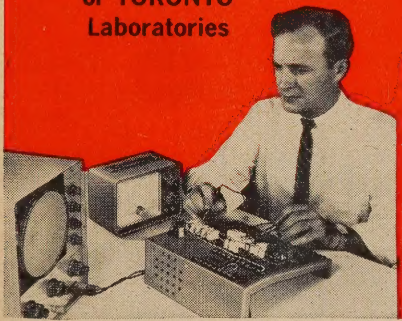
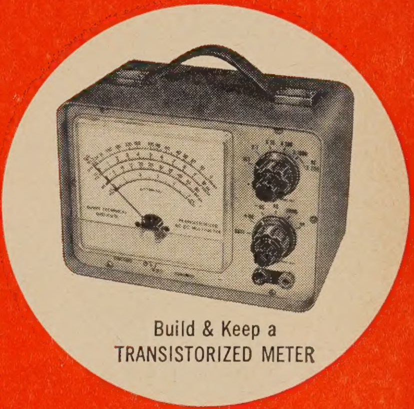


DESIGN CONSOLE for practical experiments



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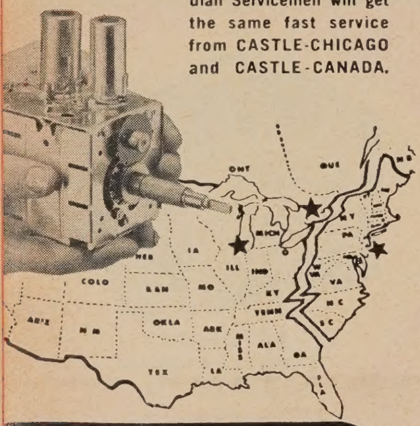

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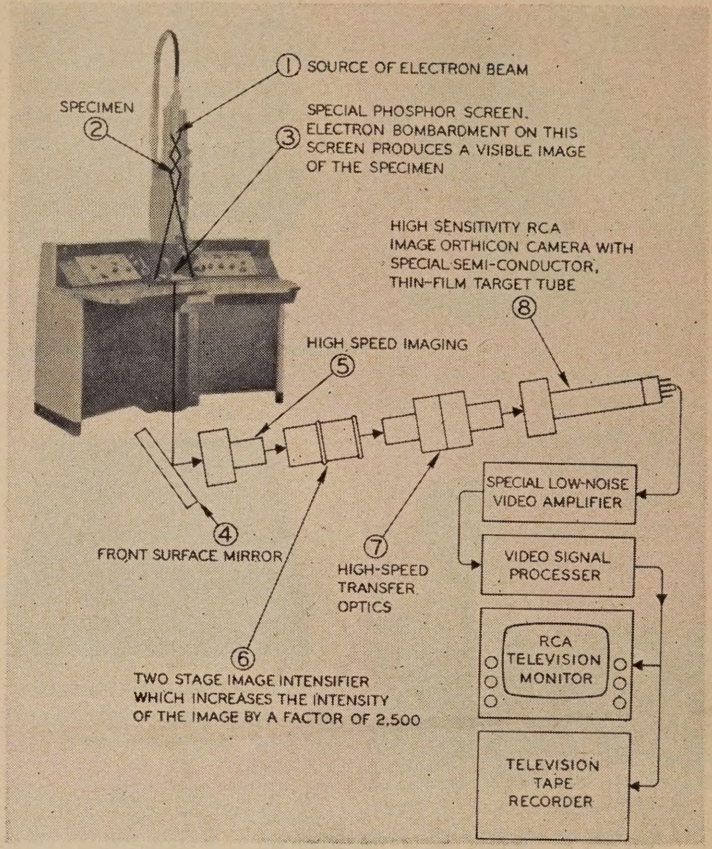
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How the intensification system works. The numbered callouts are self-explanatory, with the exception of 5 and 7, which refer simply to large-aperture optical lenses.

ELECTRON MICROSCOPE POWER BOOSTED BY TV TECHNIQUE

A technique that will make it practical to increase the magnification of an electron microscope from 200,000 times to 2,000,000 times was described by RCA at a press conference in Princeton, N.J. (At this magnification, a man's foot would be 400 miles long.)

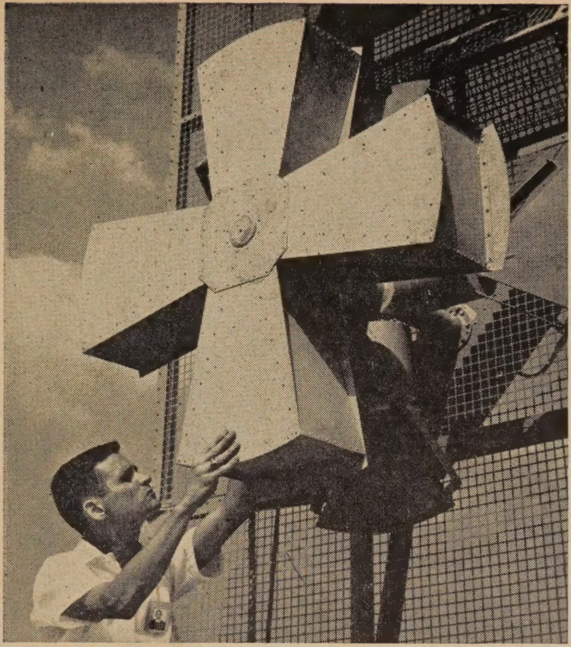
By using image intensification and television projection, it is possible to use a much weaker beam in the electron microscope itself. Heretofore the microscope could not be used to its full capability, because in many cases the specimen being examined would be destroyed by the beam. Now, by intensifying (amplifying) the visible image, it is possible to start with a much weaker image.

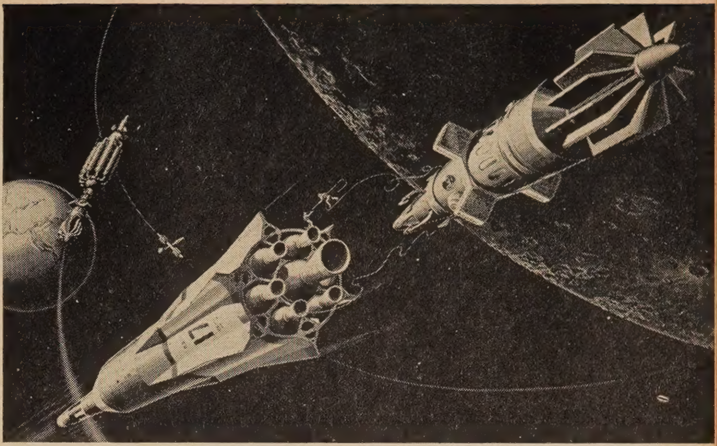
Another important advantage is that the contrast of an image can be increased beyond what would be possible with the straight electron microscope. A contrast control, not greatly different from that in an ordinary television set, can bring up the contrast. Contrast can sometimes also be improved by reversing the image—making it a negative instead of a positive—something that couldn't be done with the old electron microscope.

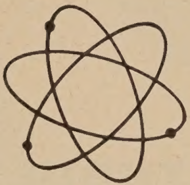
To produce these effects, the original electron microscope is focused on a phosphor screen at the original viewing point. From here it moves through a high-speed lens with a two-stage image intensifier. An image intensifier incorporates a photocathode, on which the image is focused, and which then produces electrons in the pattern of the visible image. These are accelerated to a screen where they produce an image of the same size but brighter.

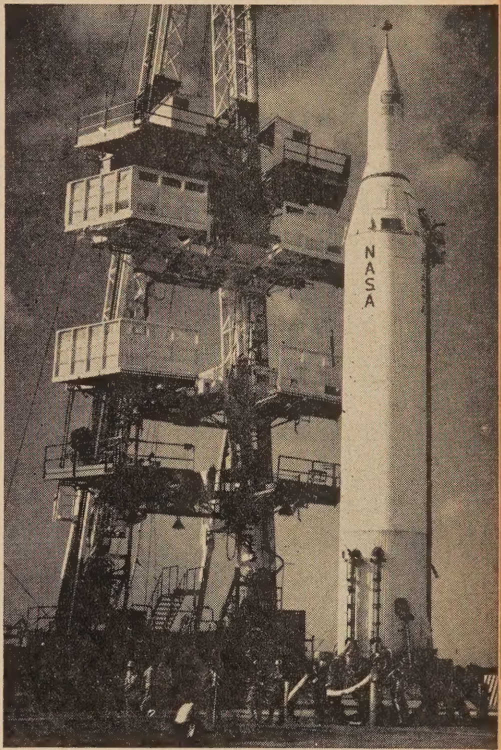
In the two-stage intensifier, this screen is a second photocathode, and the image is intensified again. It is then focused on the camera tube of an image orthicon camera, amplified through special video amplifiers and projected on the TV screen.

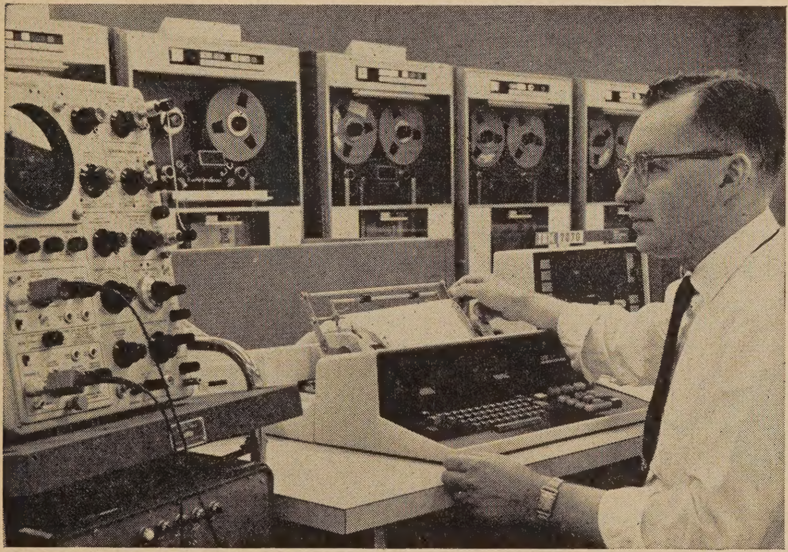
The equipment also includes a video tape recorder, so that permanent records can be made. The apparatus is in production form, ready to be delivered, either as complete equipment or as an addition to existing electron microscopes.











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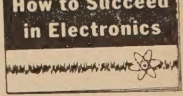

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RE-98-B

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When you pay little or no attention to quality in tubular replacement capacitors, you leave yourself wide open for criticism of your work . . . you risk your reputation . . . you stand to lose customers. It just doesn't pay to take a chance on capacitors with unknown or debatable performance records when it's so easy to get guaranteed *dependable* tubulars from your Sprague distributor!

There's no "maybe" with these 2 great SPRAGUE DIFILM® TUBULARS!

The ultimate in tubular capacitor construction. Dual dielectric . . . polyester film and special capacitor tissue . . . combines the best features of both. Impregnated with HCX®, an exclusive Sprague synthetic hydrocarbon material which fills every void in the paper, every pinhole in the plastic film *before it solidifies*, resulting in a rock-hard capacitor section . . . there's no oil to leak, no wax to drip. Designed for 105°C (220°F) operation *without voltage derating.*

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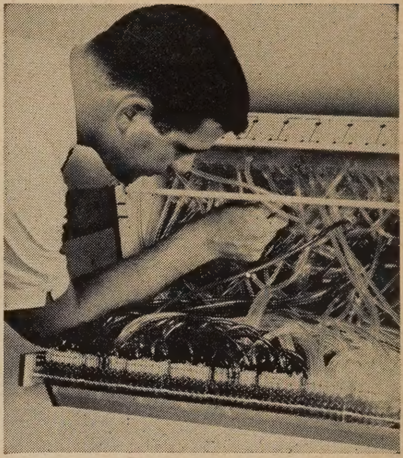

UNIVAC engineer R. S. Gluskin attaches a plastic tube to one of the elements in the experimental digital computer that works with fluid amplifiers and air.

EXPERIMENTAL COMPUTER HAS FLUID AMPLIFIERS

Air flowing to 250 molded plastic switching elements through a complex network of channels enables a new, experimental computer to perform basic computer functions. Developed by Sperry Rand Corps, Univac Div., the new computer is far from being a practical model, having a capability of only four instructions and four words of memory. Each word is four bits long.

The fluid amplifier on which this computing system is based is a device that somewhat resembles an electronic triode. A jet of fluid—which may be air—is propelled from a nozzle or cathode toward a collector, which may be placed to intercept half the stream. A small jet of fluid is directed at the base of the main stream, at right angles to it. The relatively strong main stream is deflected by the small jet, which uses little energy, so the device amplifies. (See RADIO-ELECTRONICS, August 1960, p. 56).

The fluid amplifier has already been used practically. The Army has developed a mechanical heart based fluid-amplifier principles. The same principle has been used for large hydraulic valves that work without moving parts. The Sperry Rand device, however, is the first attempt to use it as a computer, where it may eventually be practical in applications where high speed is not needed. Fluid-operated circuits can be constructed for a small fraction of the cost of conventional electronic computer circuitry. They are likely to be more reliable and can withstand higher and lower extreme temperatures, as well as nuclear radiation.

SELF DEVELOPMENT OPPORTUNITIES IN
ELECTRONICS
AND THE NUCLEAR FIELDS

CREI GRAD ROY A. REICHERT *makes an adjustment on the prototype of a programmable power supply which he designed and built in his capacity as Senior Technical Aide, Bell Telephone Labs, Murray Hill, N. J.*

If you are employed in electronics

WE WANT TO SEND YOU THE FREE BOOK

that started this man on the way to a rewarding career

Today Roy A. Reichert has a well-paying, exciting position in space age electronics. But he held a routine job when he sent for our free book, "Self Development Opportunities in Electronics and the Nuclear Fields"

From this 58-page book, he discovered the real reason why some men move ahead in electronics while others stand still. He learned the vital importance of advanced knowledge of electronics to a man who cannot be satisfied with an uninteresting, low-paying job. He found out why CREI Home Study Programs are recognized by leading organizations as particularly effective preparation for a career in advanced electronics. Mr. Reichert is just one of thousands of men in every phase of electronics who profited from reading this book. Send for free copy. Use coupon or write: The Capitol Radio Engineering Institute, Dept. 1412B, 3224 16th St., N.W., Washington 10, D. C.

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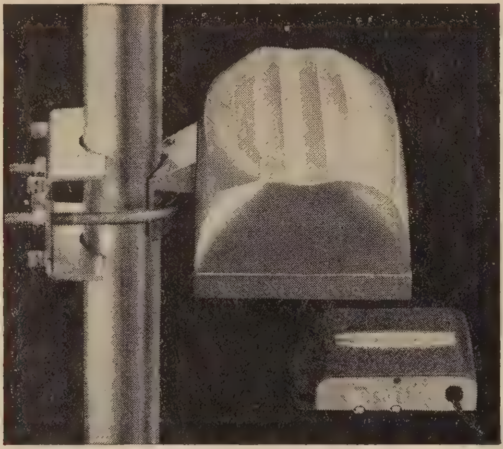
"A professional quality TV system priced for the home?"



"Try this!"

"I understand that professional TV systems use 75 ohm coax."
"That's right. Because coax minimizes interference and ghosting."
"How's that?"
"It's shielded—doesn't pick up noise. Also, it's unaffected by changing weather conditions. With 300 ohm twinlead, moisture can play havoc with the signal."
"So, that's it."
"What's more, you can feed coax thru all types of surfaces, even near metal, without interfering with performance."
"I'd like to have a system with TV outlets all over the house—bedrooms, kitchen and patio."
"The new two-transistor Blonder-Tongue Vamp 2-75 is easy to install and it can deliver sharp, clear pictures to as many as 8 TV outlets."
"Sounds real professional. What about the cost?"
"The rugged, weatherproof amplifier with remote power supply lists for only $44.95."
"I'm on my way to my dealer."

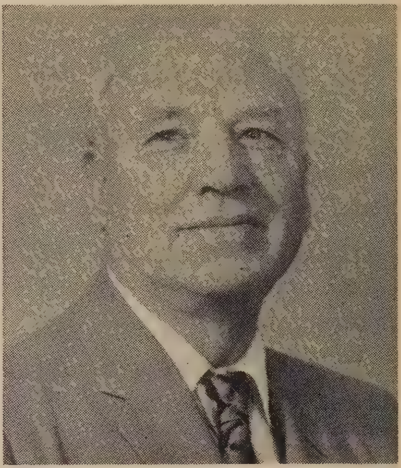
(This message was paid for out of the gross profits of
BLONDER-TONGUE, 9 Alling St., Newark 2, N.J.)

NEWS BRIEFS
continued

JOHN L. REINARTZ, W1XAM

John L. Reinartz, "World's Greatest Amateur," died Oct. 6 in California at the age of 70.

He was known to a generation of amateurs and experimenters as the inventor of the tuning circuit that was the basis for the majority of short-wave receivers in the '20's, as a pioneer in short-wave communications and as a researcher who played an important part in exploring the regions of increasingly higher frequencies.



Reinartz, though of French descent, was born in Krefeld, Germany, and came to the United States at the age of 10. His parents settled in South Manchester, Conn. He became interested in radio while he was still in school, and continued his hobby while working as a clerk in a dry goods store and later in the electrical department of a silk mill.

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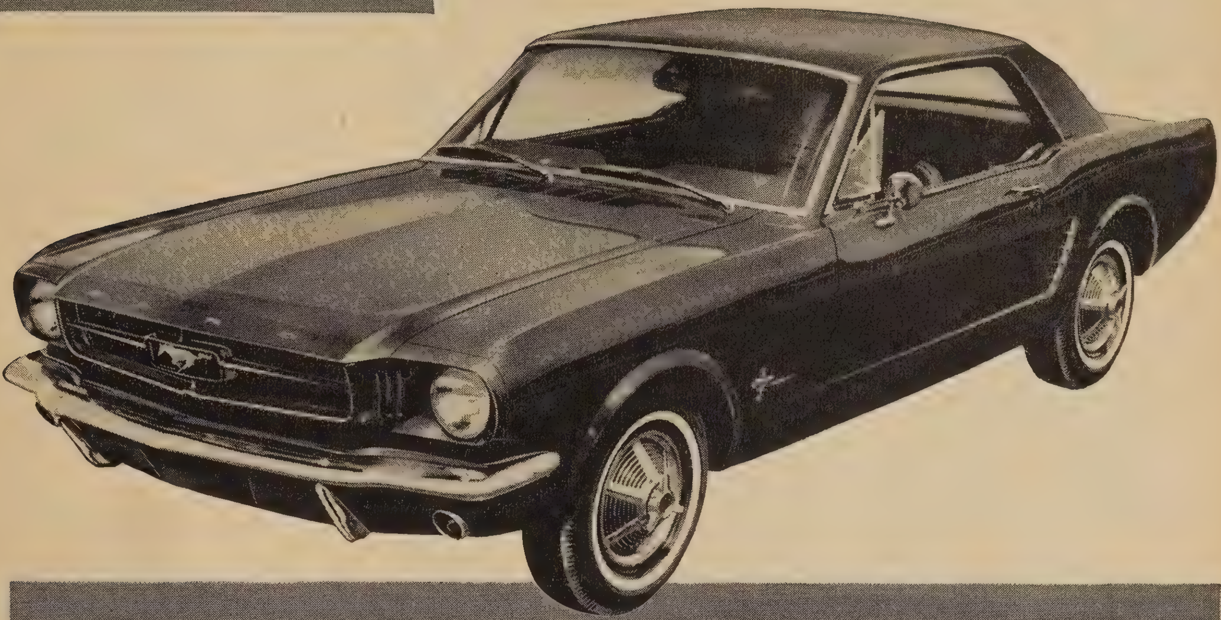
YOU CAN WIN THIS GREAT SPORTS CAR!



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New 1965 Mustang Sports Car

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THIRD PRIZE
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All entrants will receive a special gift just for entering this PHOTOFACT contest...

Contest ends December 31, 1964. Entry forms are available from your Sams Distributor or from Howard W. Sams & Co., Inc. (only one entry per contestant accepted). All you do is fill out the entry form, and have it validated by your Distributor. Winners will be determined by a drawing. *(Contest limited to U.S.A.; not valid where prohibited by State or local laws).*

DRAWING WILL BE HELD ON JANUARY 15, 1965

winners will be notified

Get Your Entry Form Today!

Enter this exciting contest now! Pick up your entry form at your Sams' Distributor, or send coupon below. Do it today! Everyone has an equal chance to win the drawing. All entries must be postmarked before January 1, 1965. Enter this worthwhile contest now!

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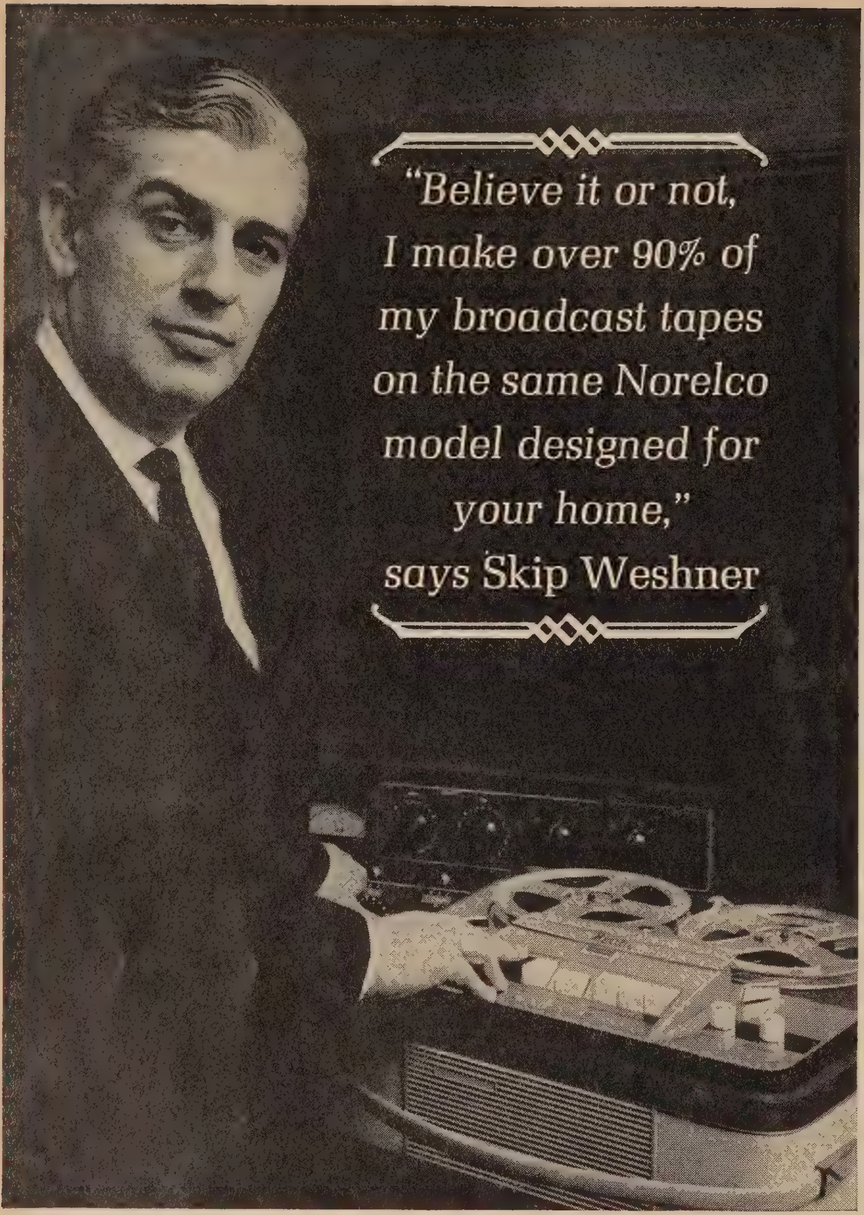


"My tapes have to meet the broadcast standards of the leading FM stations around the country, whose other taped programs are normally recorded and played back on professional broadcast-studio consoles. My Norelco '401' gives me tapes that not only meet or exceed these standards, but on playback on the '401' I defy any listener to tell the difference between my live broadcasts and my taped ones!

"As to reliability, my Norelco has been on the firing line five nights a week, month after month, year after year, and has required less maintenance than any other recorder I've ever used. It handles tape more gently, too: it doesn't break tape, it doesn't spill tape, it doesn't stretch tape—not even the half-mil stuff I'm forced to use to get an hour's broadcast on a 7" reel.

"Although the '401' was designed for the operating convenience and for the pocketbook of the home user, in my book it has proved itself as a thoroughly professional instrument."

The Norelco Continental '401': *100% transistorized • 4-speed • 4-track stereo/mono, record/playback • completely self-contained with dual preamps, dual power amplifiers, two wide-range stereo-matched speakers and stereo dynamic microphone. (Two broadcast quality microphones can be used with simple adapter.)*

At your hi-fi dealer's—or write to Dept. S-12, ***North American Philips Company, Inc., High Fidelity Products Division, 100 East 42nd Street, New York, N. Y. 10017***

Norelco®

NEWS BRIEFS

continued

In 1923 he took part in the first two-way radio contact across the Atlantic, with Leon Deloy of the French amateur station 8AB, on approximately 100 meters. When the MacMillan National Geographic Arctic Expedition was started in 1925, he was selected by Capt. Donald B. MacMillan as operator because of his capabilities and experience in short-wave radio.

Later he joined the technical staff of the amateur magazine *QST*, and also contributed many articles to other publications. Reinartz had many opportunities to become wealthy on his inventions, but remained a strict amateur, dedicating his discoveries to the public and refusing to allow major radio companies to use his name in advertisements.

During World War II he was in charge of radio training for the Naval Communications Reserve, with the temporary rank of captain. In 1949 he joined Eitel-McCullough, a tube manufacturer well known to hams. He headed the company's amateur service department until his retirement in 1960.

Mr. Rienartz held an earlier call, 1QP, before making W1XAM famous throughout the world. After moving to the West Coast, he held the call K6BJ. He was a member of the Explorers Club of New York, Fellow of the IEEE, member of the American Polar Society and an associate member of the Naval Institute.

CALENDAR OF EVENTS

1964 Mid-America Electronics Conference (MAECON), Nov. 23–24; Kansas City, Mo.

15th Annual Vehicular Communications Symposium, Dec. 3–4; Cleveland-Sheraton Hotel, Cleveland, Ohio

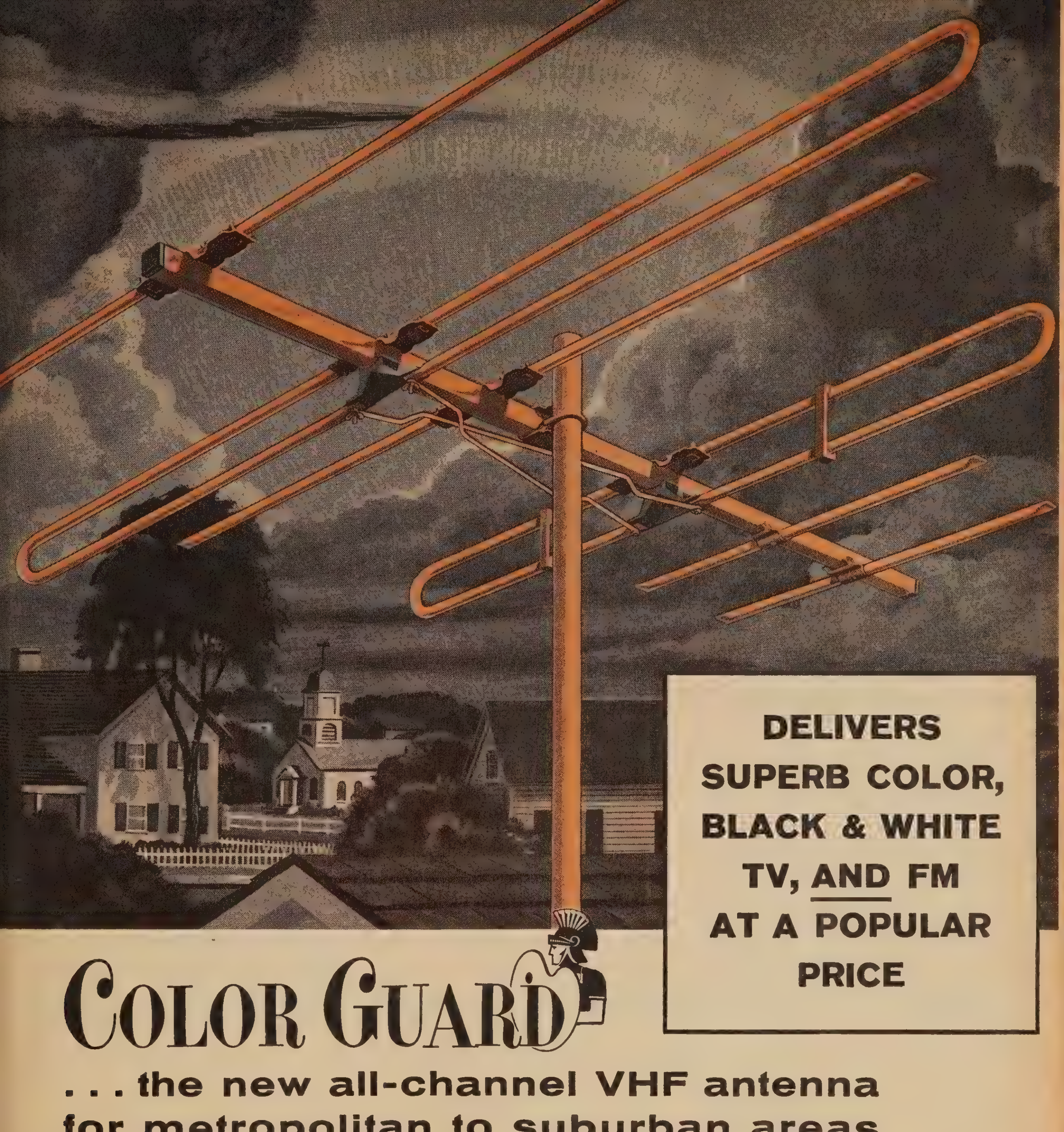
11th Annual Symposium on Reliability & Quality Control, Jan. 12–14; Fountainebleu Hotel, Miami Beach, Fla.

SCHOOL SYSTEM GETS MOBILE ETV STUDIO

A mobile television studio that can be "plugged in" to a coax cable to transmit educational programs throughout the public schools was introduced recently in Darien, Conn.

The mobile studio, a complete television station in miniature, is housed in a 34-foot trailer bought second-hand by the Darien Board of Education for $2,500. Power for the programs, which can be live, taped or on film, comes from a 7½-kw generator in the trailer tractor when no standard outside power is available.

The installation, made largely by Sylvania, contains two Sylvania 800/V cameras, two 8-inch monitors, lighting



DELIVERS SUPERB COLOR, BLACK & WHITE TV, AND FM AT A POPULAR PRICE

COLOR GUARD

. . . the new all-channel VHF antenna for metropolitan to suburban areas

It takes a good antenna to deliver good color TV pictures. Color carriers are not only weak, but phase-modulated. For this reason, antenna gain must be not only high, but flat across the entire frequency spectrum.

Because Color Guard antennas meet the stringent requirements of color TV, they're better for black & white and FM stereo reception too. Yet you can sell a Color Guard antenna for as little as $9.95 list.

Outstanding among the Color Guard series is the Coaxial Color Guard. Coaxial cable is highly recommended for color installations. It maintains constant impedance match (no ghosts or color changes), won't pick up interference, and is impervious to weather conditions. While most antennas require a separate matching transformer for use with 75-ohm coax, the Coaxial Color Guard is already matched to 75 ohms.

Any of the Color Guard antennas can be used to provide excellent FM stereo reception. All you need is Jerrold's inexpensive Model TX-FM splitter and you can feed a TV and an FM set simultaneously from the same Color Guard. See your Jerrold distributor or write for complete information on Color Guard—the perfect antenna for all your customers—from metropolitan to suburban reception areas.

Jerrold Electronics,
Distributor Sales Division, Phila. 32, Pa.

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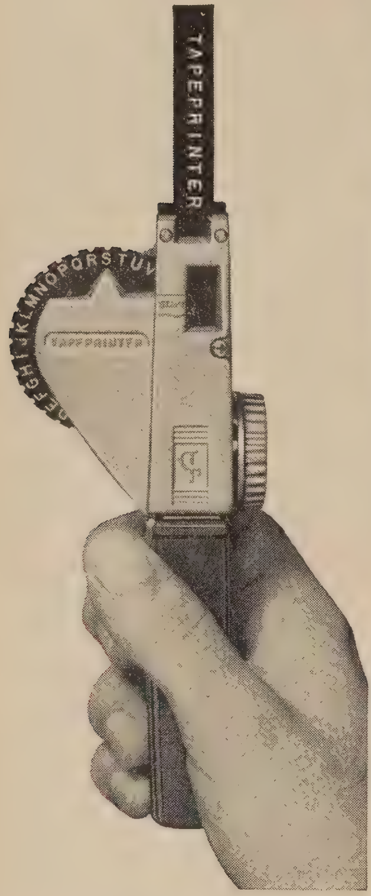
A NEW WAY TO SAY

Merry Christmas



GIVE A TAPEPRINTER. It's the ideal personal or business gift. Just turn the TapePrinter dial . . . squeeze . . . and white three dimensional letters . . . on permanent, self-sticking plastic tape . . . spell out the message. Uses for the TapePrinter just won't quit . . . unlimited you might say. Identi-Tape is available in every color of the rainbow. This Christmas give a TapePrinter . . . Don't write it . . . TapePrint it!

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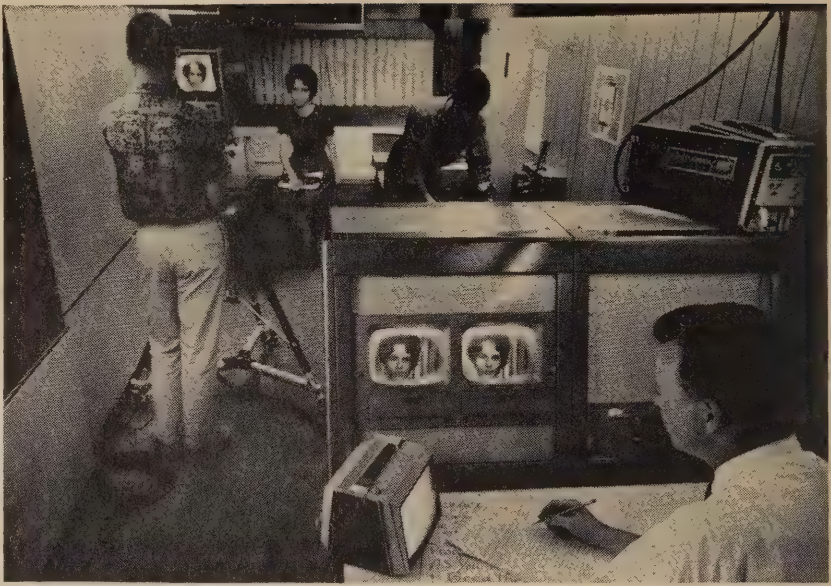

Darien students prepare taped ETV program in town school system's new mobile television studio. Faculty member, foreground, watches the monitors.

equipment, a video tape recorder, record player, audio console, projection screen, microphones and accessories.

All classrooms in Darien's seven elementary schools are linked with the closed-circuit TV system. A closed-circuit outlet has also been installed in each of the junior high school auditoriums, the high school auditorium and the Board of Education's offices. All Darien's 5,100 students can see any program considered sufficiently important, or individual elementary classrooms can see programs appropriate for a more limited audience. Live programs can be produced and transmitted from the mobile studio or taped for later broadcast, and programs from New York's educational channel 13 can be rebroadcast immediately or taped.

Cable was installed and is to be maintained by the Southern New England Telephone Co. The studio is expected to be operated primarily by interested high school students under adult supervision.

PROGRAMMED ARM-AID SPLINT ACTIVATES PARALYZED MUSCLES

The Engineering Design Center of Case Institute of Technology in Cleveland, using amplified electrical signals to bypass damaged nerves, has developed an arm-aid splint system which allows a paralyzed arm to be used for eating, shaving and other activities.

There are four subsystems, in the fourth of which the patient can select any of the activity programs stored on magnetic tape. Research on electronic tape signals making paralyzed legs walk was describe by L. Steckler in RADIO-ELECTRONICS, August 1961.

BRIEF BRIEFS

Citizens-Band interference to television is becoming serious in metropolitan areas. The New York office of the FCC reports that the number of complaints of CB interference to TV has risen to 900 a month. Owners complain of jiggling lines in the picture, and "adolescent voices" on the sound channel.

RCA is erecting two new buildings at its Lancaster, Pa. plant at a cost of $8 million, as part of a long-range expansion program in color-television-tube facilities.

Color television plans in Great Britain will probably not come to fruition until 1967, and the BBC expects to use its noncommercial second channel for color programming. Set manufacturers will probably use RCA tubes.

Sound waves at nearly 9 gigacycles a second have been generated at the Pittsburgh laboratories of Westinghouse Electric Corp in cooperation with the Air Force, by replacing thin, shatter-prone quartz-wafer transducers with ultrathin films of crystalline cadmium sulfide. The transducers are used to study the basic structure of materials like ruby and sapphire. END *you get* **PRODUCT PLUS** *from your Sylvania Distributor*

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COLOR TV HAS A NEW RED STANDARD

Sylvania's new **EUROPIUM RED.**

New COLOR BRIGHT 85 picture tube brings more natural color to television and increases monochrome brightness 43%.*

The startling news in the television industry is Sylvania's new picture tube, and its new, truer red phosphor.

EUROPIUM RED, developed at GT&E Laboratories, is the brightest red known to the industry. And, to match it, now the full brightness of blue and green is used. The result is a color picture tube that gives the entire television industry a boost.

Because the COLOR BRIGHT 85 tube is *really* bright, dealers can demonstrate color TV effectively in normally lighted showrooms. As the set's brightness is adjusted, the colors remain true—not shifting to unnatural tones in the highlights of the picture.

Another thing, black and white performance is far better than you've ever seen before in a color tube. Besides the increased brightness, there's improved contrast in a sharp, vivid picture.

The new, exciting COLOR BRIGHT 85 picture tube is a product plus from Sylvania for the entire color television industry, and particularly for dealers. In color, as in black and white, you know it's good business to handle the Sylvania line.

SYLVANIA

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS GT&E

NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

*Tests show the COLOR BRIGHT 85 tube is 43% brighter, on the average, than standard color picture tubes.

You get more for your money from NRI-

than from any other home-study Electronics, Radio-TV school

Compare if you like. You'll find—as have so many thousands of others—that NRI training can't be beat. From the delivery of your first lessons in the remarkable, new Achievement Kit we send you, to "bite size", easily-read texts and carefully designed training equipment . . . NRI gives you more value than any other home-study school. Shown below is a dramatic, pictorial example of training materials included in just *one* NRI Course. *Everything* you see pictured below is included in low-cost NRI training. Other major NRI courses are equally complete. Text for text, kit for kit, dollar for dollar—your best home-study buy is NRI.

ACHIEVEMENT through ELECTRONICS
nri
SERVICING

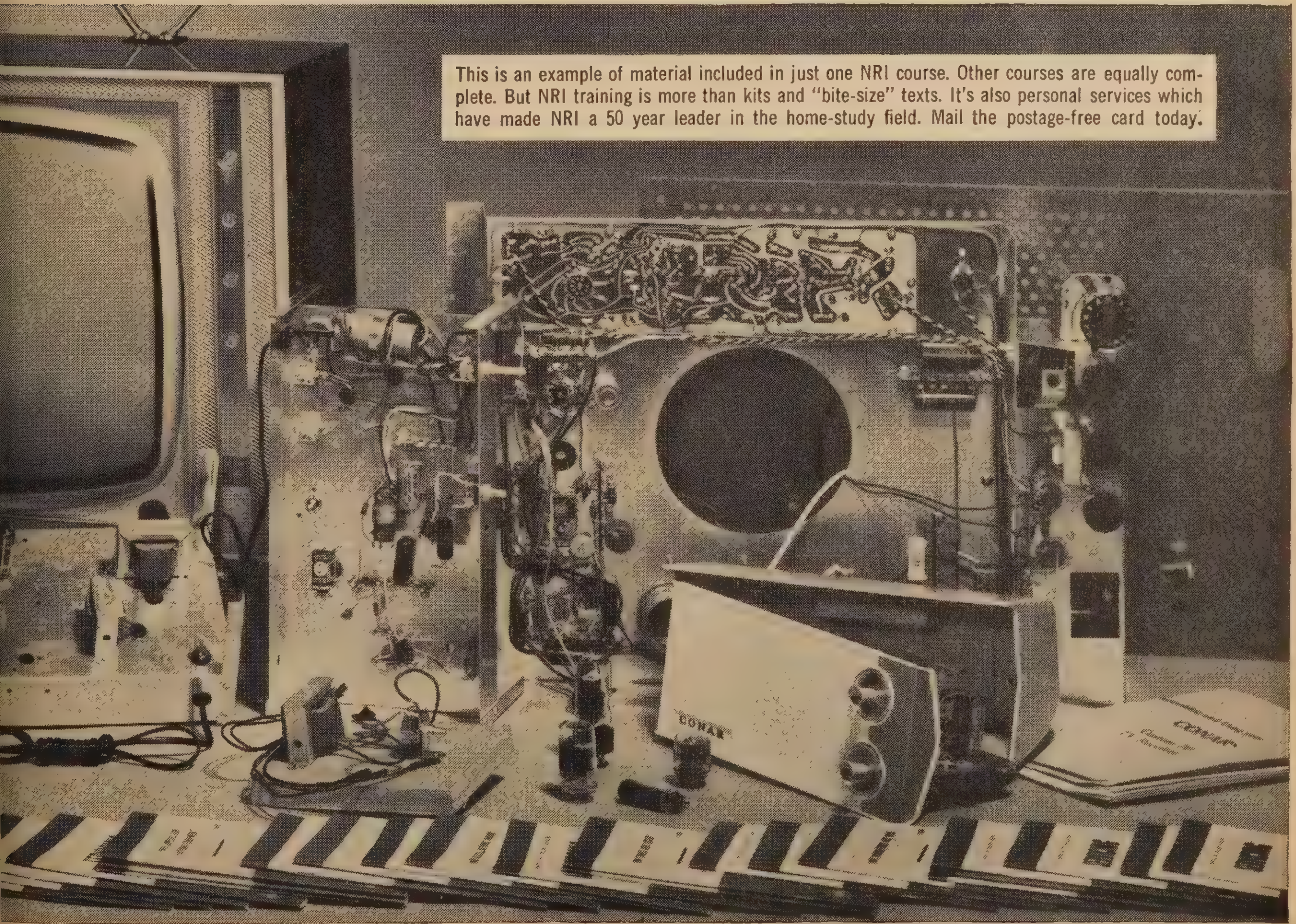
GET A FASTER START WITH NRI'S NEW EXCLUSIVE ACHIEVEMENT KIT

The day we receive your enrollment application we mail out your Achievement Kit. It contains everything you need to make an easy, fast start in the Electronics training of your choice. This attractive, new starter kit is an outstanding, logical way to introduce you to home-study as NRI teaches it . . . an unparalleled example of the value of NRI training . . . training that is backed up by a dedicated staff and the personal attention you should expect of a home-study school. It is your first of a number of special training aids carefully developed by the NRI laboratories to make your adventure into Electronics absorbing, meaningful. What's in the Achievement Kit? Your first group of lesson texts; a rich vinyl desk folder to hold your study material; the industry's most complete Radio-TV Electronics Dictionary; valuable reference texts; lesson answer sheets; pre-addressed envelopes; pencils; pen; engineer's ruler—even postage. No other school has anything like the NRI Achievement Kit.

LEARNING BECOMES AN ABSORBING ADVENTURE WITH NRI TRAINING KITS

Electronics comes alive with NRI training kits. What better way to learn than by doing it? That's why NRI pioneered and perfected the "home lab" technique of learning at home in your spare time. You get your hands on actual parts and use them to build, experiment, explore, discover. NRI invites comparison with training equipment offered by any other school. Begin NOW this exciting program of practical learning. It's the best way to understand the skills of the finest technicians—and make their techniques your own. Whatever your reason for wanting to increase your knowledge of Electronics . . . whatever your field of interest . . . whatever your education . . . there's an NRI instruction plan to fit your needs, at low tuition rates to fit your budget. Get all the facts about NRI training plans, NRI training equipment. Fill in and mail the attached postage-free card today. No salesman will call. NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.

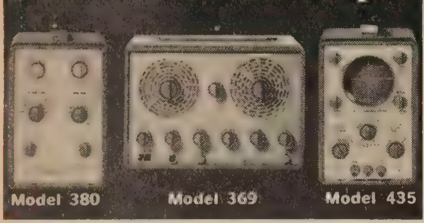
OUR 50th YEAR OF LEADERSHIP nri IN ELECTRONICS TRAINING



This is an example of material included in just one NRI course. Other courses are equally complete. But NRI training is more than kits and "bite-size" texts. It's also personal services which have made NRI a 50 year leader in the home-study field. Mail the postage-free card today.

CARD REMOVED

EICO's complete new color TV lab for the pro



Color TV servicing is a job for professionals—and **Eico's new color TV test equipment** is designed to their requirements. Critical professionals know they can depend on EICO for accuracy, reliability, and laboratory standard performance.

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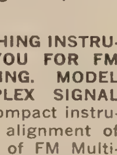

Correspondence

IMPROVED TRANSISTOR NUMBERING

Dear Editor:

Last November, I sent a suggestion to several transistor companies for a new transistor identification system. One company forwarded my letter to the Joint Electron Device Engineering Council (JEDEC). I have not been informed of any further action on the matter. Perhaps some of your readers would be interested in my proposal.

I have noticed that the majority of semiconductors are designated with the prefix "1N" for diodes and "2N" for transistors. This correctly indicates that the diodes contain one n-type junction (and, of course, one p-type junction). With transistors, this is only partially correct.

A n-p-n transistor contains two n-type junctions. A p-n-p transistor contains only one n-type junction but two p-type junctions.

I feel the classification system could be improved by giving n-p-n transistors a prefix of "2N" and p-n-p transistors a prefix of "2P". This classification could be added to all new publication without disrupting or outdating previous material.

This system would assist, not only the design engineer, but also service technicians of all levels. One could look at the number on the case of a transistor and immediately know whether he was looking at a n-p-n or a p-n-p. This system would also speed up the selection of a substitute transistor or the initial selection of units for a circuit design. Rather than look at the characteristics of each transistor in a long column, one would have to look only at the particular types (either n-p-n or p-n-p) needed in his particular circuit. The column of part numbers would tell him this.

Using this new system, a 2N35 transistor would keep its same designation, but a 2N36 transistor would be changed to 2P36.

STEVE STUMPH

Lawndale, Calif.

JPL PART OF CIT

Dear Editor:

In your October editorial, you refer to the Jet Propulsion Laboratory as being a part of the National Aeronautics & Space Administration. Admittedly, it often appears that this is the case, but actually JPL is a part of the California Institute of Technology.

I commend you on your interesting and informative magazine and perceptive editorials.

ALLEN C. GAETJENS

Paoli, Pa.

THE LITTLE FRUSTRATOR

Dear Editor:

"The Little Dictator," by William D. Rexroad, was two pages of frustration, misinformation and failure to understand the problems of machine dictation. Inexpensive Japanese tape recorders in the $15 to $20 price range are little more than toys. Adding modifications and accessories will not make a dictating machine in any true sense of the word.

A good dictating tape machine should have a modulation light or meter. The microphone should have not only a start–stop switch, but also control over rewind, playback and record. With "The Little Dictator" there is a possibility of erasing the tape when rewinding. There is no fast forward, a necessity in a true dictating machine. The microphone and footswitch cables will soon become a service technician's nightmare. The No. 26 hookup wire will not take the movement and flexing that these cables get and will break and cause intermittent operation.

"The Little Dictator" is devoid of any place-finding or indexing system. It uses but a single control for both recording level and playback volume. This can be disastrous. If the control is set for low-level playback, it might not be high enough for good recording (or the reverse). No battery-life indicator is available and the use of two types of batteries can cause confusion. The variable tape speed on these instruments will be a constant source of annoyance. Due to battery voltage variations, no two instruments will run at exactly the same speed. These problems cause trouble in transcribing due to changes in pitch, slurring, coasting and clipping of words.

"The Little Dictator" will do more to alienate potential users of dictation equipment than it will ever convert.

RALPH L. DEAN

Ventura, Calif.

[Mr. Dean has pointed out some very pertinent points, but may have been a little hard on both author Rexroad and the many users of cheap tape machines.

It was not our intent to suggest that a $20 machine would, even with modifications, be a substitute for a $200 piece of dictation equipment. But even unmodified tape recorders can be useful for dictation—as we here at RADIO-

continued on page 24

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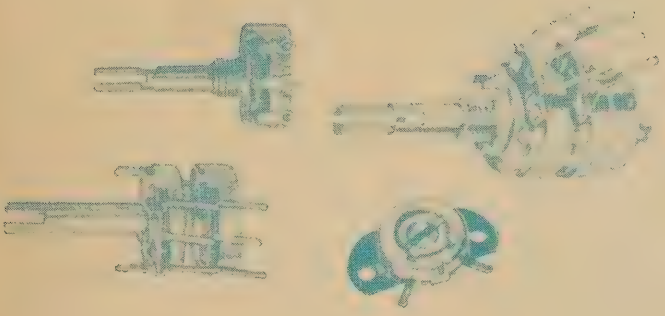

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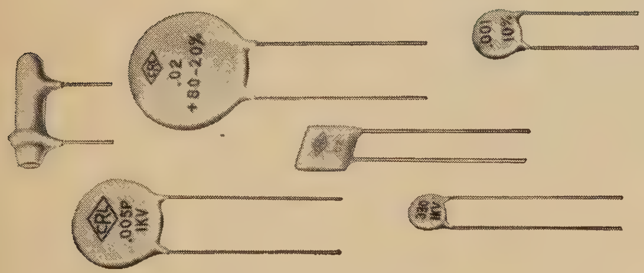

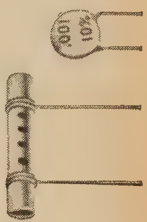

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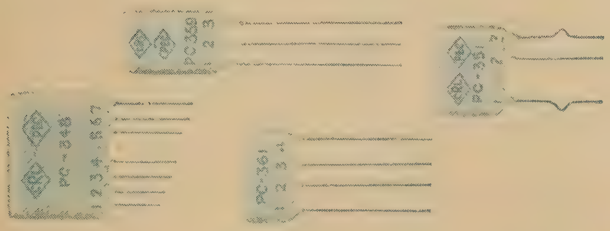

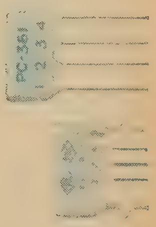

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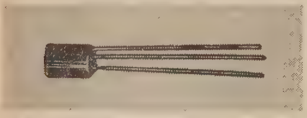

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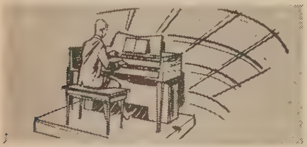

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ELECTRONICS discover daily. Adding a mike switch and foot switch greatly increases the convenience, and even without place-finding we manage to go through a large volume of correspondence every day, quite efficiently. Though our machines are ac-operated and do have fast-forward and volume indicators, sometimes we do some emergency dictating on a small reel-driven portable much like the one Mr. Rexroad used (without foot switch). We can say from experience that the difficulties Mr. Dean enumerates are there, but are not as troublesome as he believes, and even a simple machine is usually better than none at all when you want to record your thoughts promptly and efficiently.—*Editor*]

WHY ZENERLESS?

Dear Editor:

The transistor ignition system in the article "Zenerless Transistor Ignition" (September 1964, p. 34) is technically unsound. To build a transistor ignition just to have transistors in the ignition is ridiculous. Don't get me wrong—I'm a strong believer in solid-state ignition, but the system in the article offers as its only advantage long point life with few point adjustments.

A good transistor system use a special low-inductance-primary, high-turns-ratio coil. The low inductance allows current to build up faster and keeps ignition voltage constant from idling to high engine speeds.

The "Zenerless" system cannot increase gas mileage. Why should it? The ignition system is unchanged except that it operates with cooler points. The increase in mileage must have been due to a good tuneup.

Why do away with the Zener diode and add two more transistors? The Zener is reliable, costs little and protects the transistor when used with the much-needed special coil. Two-transistor versions are available without the Zener, yet with the low-inductance, high-ratio coil.

I have conducted 5,000-mile tests with and without one of the better transistor systems on a 1960 Corvair and a 1963 Rambler. The results showed good performance with transistor systems, but negligible increase in gas mileage.

J. S. BYRD

Aiken, S. C.

To which author King replies:

"The Zener for the one-transistor system costs about $7, and the coil $7 to $15. The two extra transistors cost $9.

"My system does not draw the high current of the special-coil system, and it is not necessary to replace the ballast resistor or primary ignition wiring to carry the higher current.

"All cars I tested have shown an increase in performance *and* mileage. I believe that is due to the fact that the spark fires the correct plug at the correct time, every time.

"Though I would not recommend this system for all-out racing, it has worked well for the past two years in a fuel-injected Corvette at engine speeds up to 7,000 rpm."

WILLIAM C. KING
Downey, Calif.

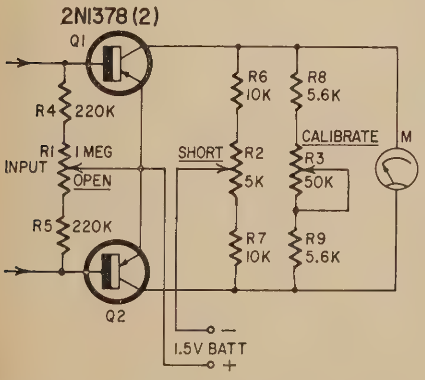
To which we add:

There are two types of advantages in electronic ignition. For the average driver in an ordinary automobile, a transistor ignition system offers longer point life and less plug fouling. This can be had even with the car's original ignition coil if the design uses either a high-voltage transistor or several lower-voltage transistors in series. High voltage drops with increasing rpm just as in ordinary ignition.

A transistor ignition system *can* develop a higher voltage that does not drop as rapidly with engine speed. For that, it requires a special coil with a low primary inductance to allow a faster rise in primary current. This type of coil can be designed for a higher turns ratio so that it develops a lower-than-usual back-emf across the primary. Then it is safe to use lower-voltage transistors.—*Editor* END

CORRECTION

The schematic for "Measuring Nanoamperes" (R-E, June 1964, page 39) is incorrect. It should be as shown here, with the CALIBRATE network (R3,



R8, R9) and the meter directly between the collectors of Q1 and Q2, rather than after R6 and R7. The rest of the circuit is correct as drawn originally.

Our thanks to Mr. L. D. Acker of Allentown, Pa., for bringing this long-lost error to our attention.

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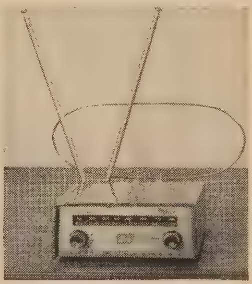

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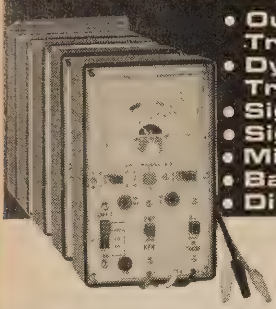

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Next Month

Radio-Electronics

COLOR TV ISSUE

JANUARY ISSUE

on sale
December 17

See Page 85 for details

HURRICANES, TORNADOES AND ELECTRONICS

. . . Electronic Techniques May Solve Storm Mysteries . . .

Both hurricanes and tornadoes are still largely unsolved mysteries. Both are still huge killers: since 1900 hurricanes have killed more than 12,200 persons and have caused billions of dollars in property losses in the United States. Each year brings an average of 10 hurricanes and tropical storms in the United States. Yet, no one knows for certain what causes these storms.

These cataclysms, as far as we know, are huge heat engines. Thus, for instance, the recent hurricane Dora measured 600 miles across and its wind reached 125 mph. Meteorologists tell us that they are high wind eddies because the temperatures are lower than the surrounding atmosphere. Surface winds are often as high as 150 mph and can reach 200 mph. However, the forward movement is comparatively low, seldom reaching 40 mph.

Our best countermeasures to date have been the Tiros VII and Tiros VIII satellites which photograph the tops of storms and give us a good indication where they are headed. In tracking hurricanes, particularly along the Gulf of Mexico and the Atlantic Coast, men known as "hurricane hunters" and two new unmanned weather stations called Marine Meteorological Observing Stations (MAMOS) are also used. In addition, we have MAMOS buoys, 20 x 12 feet, anchored in the Gulf of Mexico; these also give us useful and important weather information every hour by radio when storms are brewing.

The situation with tornadoes is very similar. Up to a comparatively short time ago the Weather Bureau did not even wish to give out advance information on tornadoes until more was known about them. Recently the Weather Bureau's Severe Local Storm Forecast Center (SELS), which now sounds an advance alarm, told us that we have from 600 to 800 full-blown tornadoes a year. Over the entire earth's surface there are 44,000 such storms every day; some 1,800 of them can be in action at any given moment.

Today, 651 weather-observing and radar stations feed more than 1,750,000 bits of important data every day into SELS in Kansas City. Electronic computers take all this information and process it constantly. Such information comes from many reporting points to teleprinters and can be automatically compiled and analyzed in high-speed processing machines in about 45 minutes.

Tornadoes differ from hurricanes because their area is smaller and their intensity tremendously greater. A tornado's diameter may vary from a few hundred feet to a half mile or so, with winds of almost incalculable force. Its path may be only a few miles long, but in that few miles it can destroy millions of dollars worth of property.

The National Severe Storm Laboratory is now watching through its orbiting weather satellites for tell-tale vortices in overhead cloud covers; ground stations could also monitor suspicious thunder clouds for various electrical fluctuations.

Nowadays high-flying pilots or perhaps even rockets can "seed" the clouds with dry ice (perhaps other more effective agents will some day be discovered) which can speed the condensation and drain the clouds of their moisture.

It seems quite possible that in the future, by judicious application of dry ice or other refrigerants, we can reduce both hurricanes and tornadoes to the barest minimum; in other words, take the sting out of them.

In our opinion, by the year 2000 it should be possible for man to have conquered both hurricanes and tornadoes, and largely reduce them to a point where they are no longer a menace to life and property. It will be a costly operation to do all this but in the end it is believed that by some means of electronics the menace can be removed entirely, or at least largely minimized.* —H.G.

---

*Part of this information was furnished by *Empire* (September 1964) Magazine, and *Science Newsletter* (September 26, 1964).

Merry Christmas—Happy New Year

The Staff of Radio-Electronics

High-Quality Transistor Radio You Can Build

Flexible, proven design makes sensitive, good-sounding AM receiver

By PAUL A. GRACE*

HERE'S A SENSITIVE 10-TRANSISTOR RADIO that compares favorably with the better name-brand receivers. Yet it is noncritical in layout and construction. The design has been adapted carefully from experience on more critical layouts, so normal components will perform well.

The chassis is a perforated phenolic board sold by many radio supply houses. If possible, get the type with copper bonded to one side; this provides a better ground connection than does a single bus wire. The copper can be peeled from areas where it will cause shorting, and left as a shield on the rest of the chassis. I used a piece 3⅝ x 10 inches, obtained by cutting a standard 7½ x 10-inch board in half.

The layout in the photographs represents a compromise, between size and shape and freedom from feedback. Many similar layouts should work almost as well. If you try a different layout, remember that the most serious feedback occurs from the secondary of the last i.f. transformer and the diode detector with its associated filter (R12, C7 and C8). If these parts are well away from the antenna, rf stage and mixer, there should be little trouble with instability.

This circuit owes its fine tone quality partially to the transformerless output circuitry. A 25- to 50-ohm speaker is required. I used a 45-ohm speaker intended for intercom service.

The copperclad board used here gives you a chance to try printed-circuit type layouts without masking or etching. The copper can be scribed with one medium-pressure stroke with an awl or regular machinist's scribe. You don't have to cut completely through the copper to assure a clean edge. Be careful —a slip may ruin a connection.

Lift one corner of the piece to be removed with a very sharp knife, such as model makers use. Grasp it with heavy tweezers, or long-nose pliers or a small pair of diagonal wire cutters, and pull slowly. I prefer the cutters. With patience, whole sections can be removed as a single piece.

Small spring flea-clips are used for the transistors to eliminate drilling large holes for regular sockets. These prevent heat damage to the transistors from soldering and allow changing transistors easily for experimental work. Remove the copper far enough from the transistor sockets to allow for a row of insulated holes on both sides of the clips.

You can correct some scribing and cutting errors by flowing a layer of solder over the copper after the circuit is completed. Use a light coat of flux on the board to reduce soldering time. Excessive heat can cause peeling.

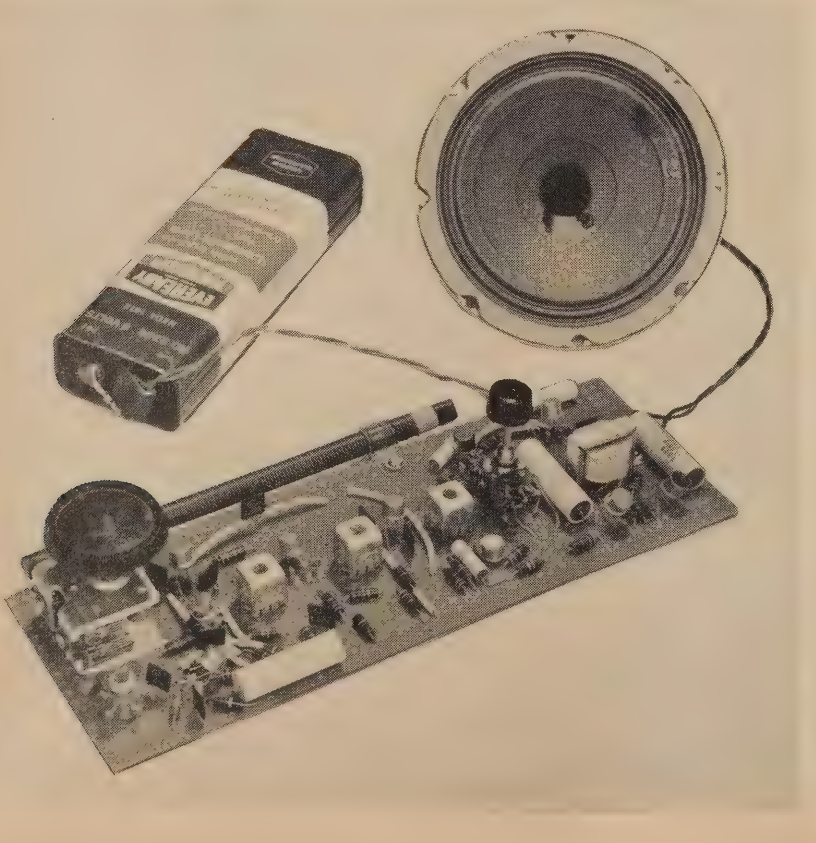
The photos show how the antenna is mounted. The rod was attached with two ½-inch plastic cable clamps and 6-32 screws. The copper on the board was peeled back an inch to avoid detuning the antenna. Metal or wire clamps will ruin the sensitivity of the radio. The variable capacitor has threaded holes on the front, back and bottom and can be attached in any position. Use very short screws so that they will not touch the delicate plates inside.

The i.f. cans can be mounted by enlarging the proper holes on the board with a 5⁄32-inch drill. The connection lugs should clear the holes, and the mounting tabs pass through holes and are soldered to the copper. Test-fit the cans gently to be sure before drilling. New holes will have to be drilled for the can grounding lugs—they do not line up with the board holes. Be careful not to force the i.f. cans into the boards.

The oscillator coil may give trouble, because the diagram included with it is rather difficult to understand. The coil terminals are read clockwise from pin 1, identified by a dot of green paint. Remember to count around looking from the *bottom,* not the top.

Start with the audio portion since it is the least critical. Mount the large electrolytics (C1, C2, C5) first.

The driver transformer needs a minor modification to get a split secon-



The completed set, less cabinet and frills. It can become a portable or a table model.

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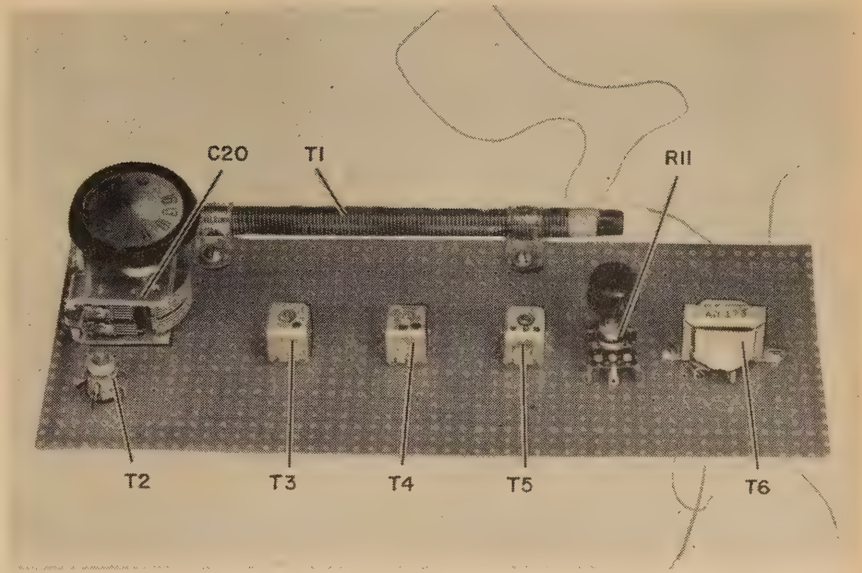
*Raytheon Marine Operations, South San Francisco, Calif.

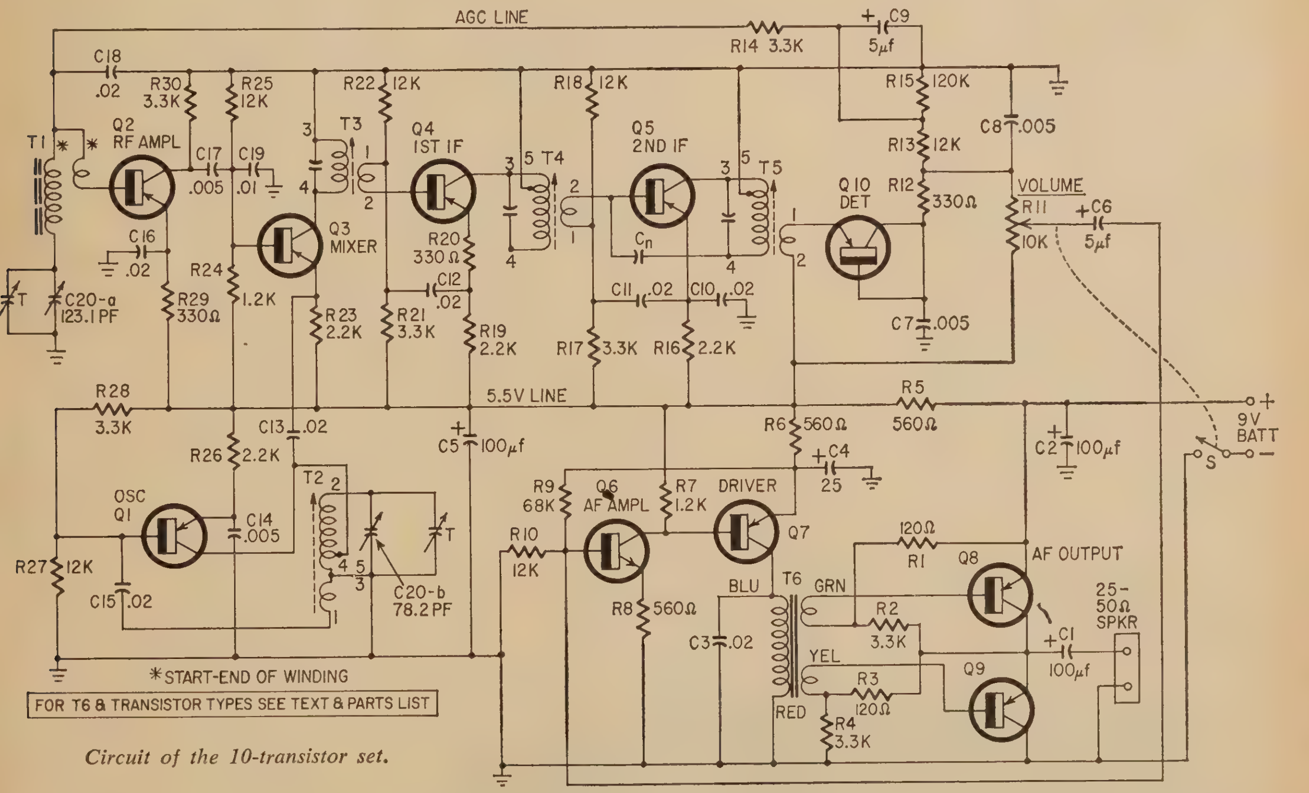
dary winding. The first step is to carefully cut the insulating tape vertically in the center of the secondary side of the transformer, one layer at a time, until the connection loops of the winding wire are exposed. The secondary has a yellow wire at one end and a green at the other. The black center-tap lead is soldered to a loop of fine copper wire. If one end of the loop is carefully broken away from the black wire and soldered to another piece of insulated wire, a split secondary results. Be careful not to disturb the green or the yellow wire.

The transformer can be taped tightly again with masking tape and the two center wires identified with an ohmmeter. The dc resistance of the secondaries should be similar and will measure about 50 ohms each side in the AR-173. Phasing is important. The yellow wire goes to the base of Q9, and the other end of that winding goes to Q9's bias point. The green wire goes to the base of Q8 and the other end to Q8's bias point.

The preamp and driver stages have a high input impedance and high gain, so the leads should be kept short. Mount the volume control by attaching wires to both the volume and switch connections and pushing them through the board. One wire from the switch is soldered directly to ground and one from the volume control directly to the +5.5-volt line. These hold the control nicely.

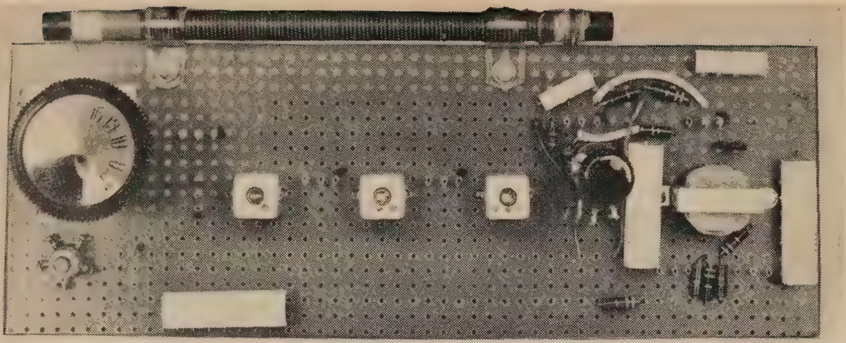

C20
T1
R11
T2
T3
T4
T5
T6

Begin by mounting parts. Follow a logical order like this or other schemes described in text. Perforated, copper-clad board saves work.


AGC LINE
R14 3.3K
C9
5µf
C18
.02
R30
3.3K
R25
12K
R22
12K
R18
12K
R15
120K
C8
.005
T1
Q2
RF AMPL
C17
.005
C19
.01
T3
Q4
1ST IF
T4
Q5
2ND IF
T5
Q10
DET
R13
12K
R12
330Ω
VOLUME
R11
10K
C6
5µf
Q3
MIXER
R20
330Ω
Cn
C16
.02
R24
1.2K
C20-a
123.1 PF
R29
330Ω
R23
2.2K
R21
3.3K
C12
.02
R19
2.2K
C11
.02
C10
.02
R17
3.3K
R16
2.2K
C7
.005
R28
3.3K
5.5V LINE
R5
560Ω
9V
BATT
C13
.02
C5
100µf
R6
560Ω
C4
25
C2
100µf
S
R26
2.2K
T2
R9
68K
Q6
AF AMPL
R7
1.2K
DRIVER
Q7
OSC
Q1
C14
.005
R10
12K
R1
120Ω
Q8
AF OUTPUT
R27
12K
C15
.02
C20-b
78.2 PF
R8
560Ω
BLU
T6
GRN
R2
3.3K
25-50Ω
SPKR
C1
100µf
C3
.02
YEL
R3
120Ω
Q9
RED
R4
3.3K
*START-END OF WINDING
FOR T6 & TRANSISTOR TYPES SEE TEXT & PARTS LIST

Circuit of the 10-transistor set.

C1, C2, C5—100 µf, 10 v, electrolytic
C3, C10, C11, C12, C13, C15, C16, C18—.02 µf, 50 v, disc ceramic
C4—25 µf, 10 v, electrolytic
C6, C9—5 µf, 10 v, electrolytic
C7, C8, C14, C17—.005 µf, 50 v, disc ceramic
C19—.01 µf, 50 v, disc ceramic
C20—variable, 2-gang, with trimmers. Rf section 123.1 pf max; osc section 78.2 pf (Lafayette 32 G 1106)
Cn—neutralizing capacitor: 5.1 pf, 5%, mica
Q1, Q2, Q3, Q4, Q5, Q10—2N404, 2N410 (RCA)
Q7, Q8, Q9—2N408 (RCA)
Q6—2N647, 2N1605 (RCA)
R1, R3—120 ohms
R2, R4, R14, R17, R21, R28, R30—3,300 ohms
R5, R6, R8—560 ohms
R7, R24—1,200 ohms
R9—68,000 ohms
R10, R13, R18, R22, R25, R27—12,000 ohms
R11—pot, 10,000 ohms, audio taper, with switch
R12, R20, R29—330 ohms
R15—120,000 ohms
R16, R19, R23, R26—2,200 ohms
All resistors ½ watt, 10%
S—spst on–off switch (part of R11)
T1—ferrite antenna coil (Lafayette 32 G 4107)
T2—oscillator coil (Lafayette 32 G 4102)
T3, T4—i.f. transformers (Lafayette 30 G 1104)
T5—i.f. transformer (Lafayette 30 G 1105)
T6—audio driver transformer (modified Argonne AR-173)
BATT—9-v battery (size optional — larger ones give longer playing time)
SPKR—25- to 50-ohm PM speaker (Quam 4A1Z45 or 5A1Z45) or series string of lower-impedance speakers (see text)
Perforated circuit board, copper clad (Lafayette 19 G 3609)
Cable clamps for antenna mounting, flea clips for transistors (27 required) or 9 transistor sockets
Knobs and miscellaneous hardware.
Argonne and Lafayette parts are available by mail from Lafayette Radio Electronics Corp., 111 Jericho Tpke., Syosset, N. Y.



Wiring of the audio stages is complete. They can be tested independently of the rest of the receiver.

After the audio portion is complete, connect a speaker and battery temporarily. If the circuit is correctly wired, there should be some hum output when you touch the base lead of either the preamp (Q6) or the driver (Q7). If you hear no output at all, something is wrong. A dc voltage test of the output stage is a good check, but the voltages will read somewhat higher than in the chart in the driver because the rest of the set is not wired.

The most common errors are improper battery polarity, reversed polarity of one or more electrolytic capacitors, or a reversed transistor. If these all check, then the driver transformer may have one secondary out of phase.

Once the audio looks OK, build the detector circuit and i.f. amplifiers. Leads in the detector circuit must be kept short and bypass capacitor C7 mounted as closely as possible to the collector and base leads of the detector (Q10).

The ground leads on C7, C8 and C10 should be connected as close as possible to the spot where the third i.f. can is grounded. Flow a fairly heavy layer of solder onto the copper in this area to make a good ground.

The small mica neutralizing capacitor (C_n) should be connected under the board with short leads.

After the i.f. section is complete, insert two i.f. transistors, touch the transistor leads with a finger, with the volume control on full. A good hum level indicates that it is OK to continue with the front-end wiring. Under some conditions your finger will cause oscillation because of the amount of gain. Don't be alarmed.

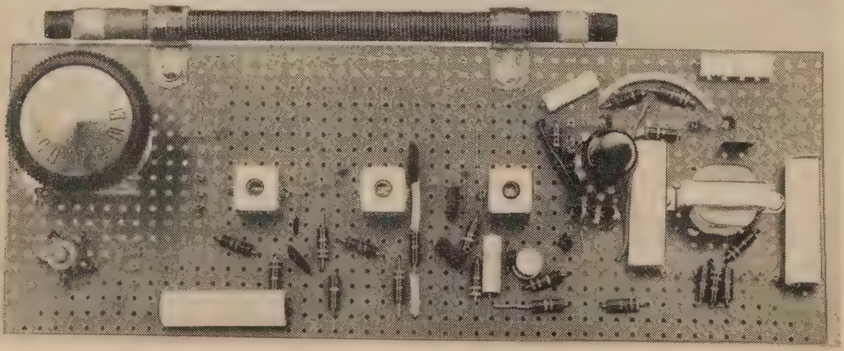
VOLTAGE CHART

Readings taken with 20,000 ohms/volt meter

	FUNCTION	EMITTER	BASE	COLLECTOR
Q1	osc.	4.3	4.1	0.0
Q2	r.f. ampl.	5.0	4.7	2.8
Q3	mixer	4.9	4.9	0.0
Q4	1st i.f.	4.4	4.2	0.0
Q5	2nd i.f.	4.4	4.2	0.0
Q6	1st af	0.43	0.50	4.4
Q7	driver	4.5	4.3	0.35
Q8	output	9.0	8.8	4.5
Q9	output	4.5	4.3	0.0
Q10	detector	5.4	5.3	5.3

Readings within ±20% of those above are satisfactory. All are taken with negative meter lead connected to circuit ground.

Everything's done but the rf, mixer and oscillator stages. Layout is roomy, easy to work with.



The front end is not difficult, but watch lead length. Make sure that the oscillator transformer is connected in the proper phase. One clue is the difference between base and emitter voltages of the mixer transistor (Q3). There may be no difference or even a reverse voltage when the transistor is oscillating. A normal p-n-p transistor's emitter is always a few tenths of a volt positive with respect to its base when biased "on" and not oscillating.

C16 and C18 must be grounded next to the emitter of transistor Q2.

Insert the transistors and turn the set on with the battery and speaker connected. Close C20 fully and run a complete dc voltage check on all transistors according to the voltage chart. If all are OK, measure the voltage at the top end of the volume control. It should be around 5.4 volts if no station is tuned in. Turn C20 through its full range. The dc voltage should swing more positive when on station. This dc voltage is your best guide to alignment and will rise to about 5.6 volts on a strong signal.

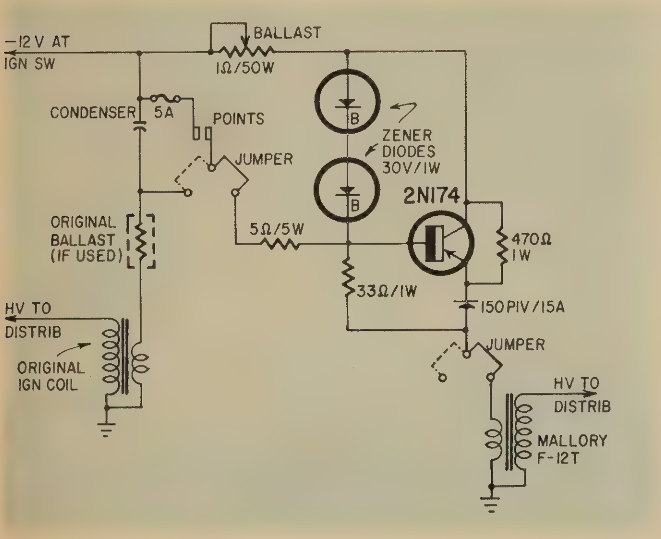
If you hear no stations, a little prealignment may help. Turn the two trimmer screws on the variable capacitor down snugly and then back off approximately a quarter turn. Adjust the core of the oscillator coil until it is just flush with the top of the coil form, then raise it a quarter turn. The second and third i.f. cores should be set about two turns below the top of the coil, and the first i.f. about three turns below. The radio should now pick up all local stations at the very least.

Tune in a local station near the bottom of the dial and check to see if the dial calibration is reasonable. Try the same thing with the highest-frequency station received. If an error exists on the high end, try adjusting the *oscillator section* trimmer screw (not the antenna trimmer) to correct this. Then tune in a station around 600 or 700 kc and *slowly* rock the tuning knob back and forth a bit while adjusting the oscillator coil slug for maximum dc voltage reading at the volume control and audio output from the speaker *when the station is centered.* These should occur simultaneously. Once this peak has been found, the i.f. slugs can be peaked for maximum output using a station around 1200 kc.

Now go to a station around 1400 to 1500 kc and adjust the *antenna section* trimmer screw for maximum output. Repeat this entire procedure and touch up where necessary. END

TRANSISTOR IGNITION FOR POSITIVE GROUND

TRANSISTOR IGNITION SYSTEMS APPEAR to be as popular in Australia as they are here. *Radio, Television & Hobbies* (Sydney, Australia) has just concluded a four-part article, "Your Car and Transistor Ignition," in which the author gave construction details on several systems for both positive- and negative-ground electrical systems.



−12 V AT
IGN SW
BALLAST
1Ω/50W
CONDENSER
5A
POINTS
JUMPER
B
ZENER
DIODES
30V/1W
B
2N174
ORIGINAL
BALLAST
(IF USED)
5Ω/5W
470Ω
1W
33Ω/1W
150PIV/15A
HV TO
DISTRIB
ORIGINAL
IGN COIL
JUMPER
HV TO
DISTRIB
MALLORY
F-12T

Fig. 1—Electrically simplest scheme requires insulating breaker points from ground (see Fig. 2).

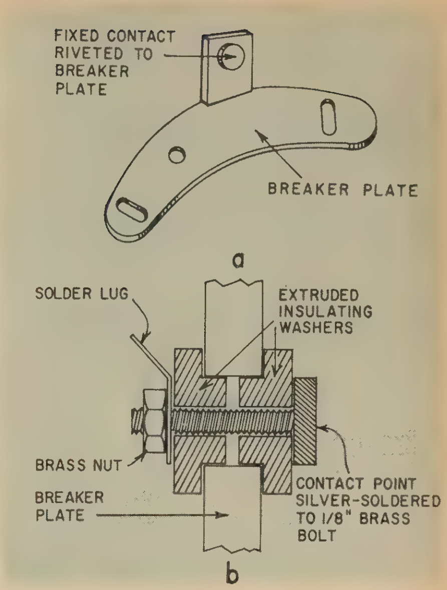
Many of our readers have asked for circuits of transistor ignition systems for 6 volts and for 6- and 12-volt circuits with positive ground. In a system for a car with positive ground, designers use either an expensive n-p-n power transistor or a p-n-p and insulate the normally grounded breaker-point contact, or a small-signal medium-power n-p-n transistor to switch the base current of the high-power p-n-p transistor.

Fig. 1 is the simplest circuit for positive-ground installations. In many circuits, a Zener diode is connected between collector and emitter to limit the back-emf across the transistor when the points open. In this circuit, the Zener diode (actually a pair of 30-volt units) is in series between the collector and base. When the back-emf reaches the Zener voltage, a voltage pulse is fed to the base to turn the transistor back on for a brief interval so the excess voltage is dissipated in the transistor.

The diode in series with the emitter protects the transistor if the input voltage polarity is reversed. This diode also insures that the base is always positive with respect to the emitter at the instant that the points open. This means that the transistor will always cut off—even at relatively high operating temperatures.

A Mallory F-12T or equivalent ignition coil is specified for the transistor circuit. The author recommends leaving the original coil in place and connecting the movable point contact and the "hot" primary lead of the F-12T to the circuit through a terminal board. In this way, the original coil serves as a backup that can be used in emergencies by connecting the jumpers as indicated by the dashed lines.

Note that the breaker points are above ground. Fig. 2-a shows a conventional breaker plate grounded through the distributor housing. Fig. 2-b shows how the point can be insulated from ground. File or grind away the riveted end of the point so it can be removed from the breaker plate. Ream or drill the hole to 3/16 in. Cut the head off a ½ x ⅛-in. brass bolt, leaving a threaded stud about 3/16 in. long. Silver-solder this to the contact point and install it with two extruded fiber insulating washers as shown in Fig. 2-b. This insulated point goes to the "hot" side of the battery. Use an insulated feedthrough to bring the insulated lead out of the distributor case.

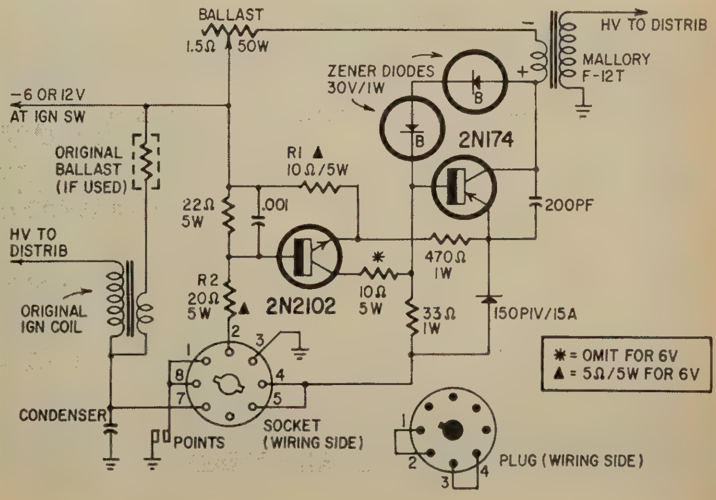


FIXED CONTACT
RIVETED TO
BREAKER
PLATE
BREAKER PLATE
a
SOLDER LUG
EXTRUDED
INSULATING
WASHERS
BRASS NUT
BREAKER
PLATE
CONTACT POINT
SILVER-SOLDERED
TO 1/8" BRASS
BOLT
b

Fig. 2-a—Unmodified fixed breaker point is electrically common to auto frame (positive); b—Modification insulates it.

Fig. 3 shows a similar circuit with an n-p-n transistor added so a p-n-p power transistor and the original point setup can be used in a positive-ground system. The circuit can be used for 6- or 12-volt operation by using the indicated values for R1 and R2. You can switch between the conventional and transistor ignition systems by moving the "hot" distributor lead to the terminal on the coil to be used and reversing the jumper plug in its socket. The socket is made by filing a second keyway between pins 4 and 5 of an octal socket.

END



BALLAST
1.5Ω
50W
HV TO DISTRIB
MALLORY
F-12T
ZENER DIODES
30V/1W
B
B
−
+
−6 OR 12V
AT IGN SW
2N174
ORIGINAL
BALLAST
(IF USED)
R1 ▲
10Ω/5W
22Ω
5W
.001
200PF
HV TO
DISTRIB
✱
470Ω
1W
R2
20Ω
5W
▲
2N2102
10Ω
5W
33Ω
1W
150PIV/15A
ORIGINAL
IGN COIL
1
2
3
4
5
7
8
✱ = OMIT FOR 6V
▲ = 5Ω/5W FOR 6V
CONDENSER
POINTS
SOCKET
(WIRING SIDE)
1
2
3
4
PLUG (WIRING SIDE)

Fig. 3—More complex electrically, but requiring no mechanical alterations, is this approach, using an n-p-n driver.

Horizontal Oscillators And AFC Circuits

The methodical approach: divide and conquer!

By JACK DARR
SERVICE EDITOR

LET'S TALK ABOUT HORIZONTAL OSCILLATORS. What they are, what they do, how they do it and what *we* do when they won't do it. The horizontal oscillator supplies the "drive" that runs the works. Lots of men think it's complicated. It isn't. We can tell exactly what's going on by making a very scientific test—we look at the picture tube! This tells us precisely what the oscillator is doing: running fast or slow, in or out of sync. We won't need a scope until later.

Horizontal oscillators can be divided into three parts: an oscillator (of any kind), a stabilizer circuit and an automatic frequency control (afc). If we have trouble, there's only one way to find out which section is responsible. Check each by itself. The oscillator must run at (or near) 15,750 cycles per second, the stabilizer steadies it and the afc holds it in sync. So, to pin down the trouble, take off *all* controls, get the oscillator running right, then add the other sections, one at a time. The oscillator in any of these circuits *can* run by itself, on or near the right frequency.

The multivibrator oscillator

Fig. 1 shows a multivibrator, with triode afc and ringing-coil stabilization. The three sections are shown inside the dotted lines. Now let's take this apart. All oscillator circuits are basically alike. They have to be—they all do the same thing! So, if we learn the basic method for any one of 'em, we can use it with all.

If we've got a raster, the oscillator is running. No drive, no raster! Lots of things can cause a "no-raster" condition, and we'll get to them later, but always remember one thing: *If the CRT screen is "lit", the oscillator must be running*, even though it may be far off frequency.

A dead oscillator ought to be easy: tube, open resistor, shorted capacitor, etc. Voltage and resistance measurements will find this pretty quick. More common is off-frequency operation, or loss of sync. Fig. 2 shows the symptoms for off-frequency operation, and what each one means.

Taking one apart

Now, let's dissect an oscillator. In Fig. 1, the afc furnishes a varying dc voltage to the grid, to control oscillator frequency by comparing sync phase with oscillator signals. Kill this by grounding the afc circuit at some point where it won't affect the dc bias—usually the afc tube's grid or cathode. Take out the stabilization by shorting the ringing coil with a piece of wire. R1 is usually about 12–15,000 ohms. You may have to increase this if it's lower than 12,000, as it is in some circuits. Change it back when you get through or leave the bigger resistor in there; makes it work better in some sets.

Now, what have we got left? Just the bare oscillator. Some circuits have hold controls: grid resistor R2 is variable, for example. In a few, the ringing-coil core is brought out through the panel and used as a hold control. If a resistor hold control is used, set it near the center. Now, turn the set on and try it on a TV signal.

The natural frequency of the oscillator ought to be 15,750 cycles or darn close to it. This will make a *single picture* on the screen. It won't be stable, since we've taken off all control; it will float from side to side across the screen, looking somewhat like Fig. 3. It may scoot from side to side pretty fast, but as long as you can tell that there is definitely just *one* picture going back and forth, fine.

What to do if it isn't? Look at it and see *what* it's doing: running fast or slow (Fig. 2). Too fast, some part is too *small;* too slow, some part is too *big*. Coupling capacitor C and grid resistor R2 are the main frequency-determining parts in this circuit, although the other resistors will affect frequency too. Check values on the schematic. The circuit worked once with those part values, and it ought to again.

Once in a great while, you'll find an oscillator that simply won't run "free-wheeling" like this (usually in off-brand sets). Here, we really ought to change something to make it run closer to the right frequency. Makes the afc's job of holding it on frequency a lot easier. Change one of the parts just a little and see what happens. To make it run faster (frequency higher), make C or R smaller; slower, C or R slightly bigger. In the better sets, you won't ever have to do this.

With the oscillator running OK, take the short off the stabilizer—here, the ringing coil. The picture will probably fall out of sync. Leave the hold control alone (if there is one) and adjust the core of the ringing coil until the picture falls back in. It'll still be floating but should be noticeably more stable. If you can't get it to come in at all, the ringing coil is bad. Why? Because it's the only "new part" we've added to the circuit! Right?

Next, put the afc back. This should make the picture lock in and hold. If the picture *was* holding, but the afc throws it *out* of sync, the afc must be bad. Same reasoning.

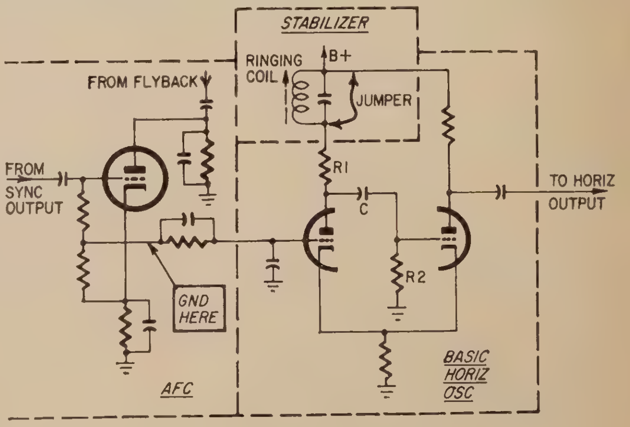


Fig. 1—A typical multivibrator horizontal oscillator. The three sections are set off by dashed lines.

Now we can check such peculiar troubles as the set that won't make a raster unless there is a signal being fed to it, and the opposite—the one that "goes dark" *with* signal and lights up when off-channel.

First one is probably oscillator trouble; the oscillator won't run at all but the afc can pull it into oscillation with sync. Second is more apt to be a bad afc circuit. As you can see, the afc is throwing the oscillator *off frequency* when a signal is applied, instead of pulling it on frequency. Check the dual

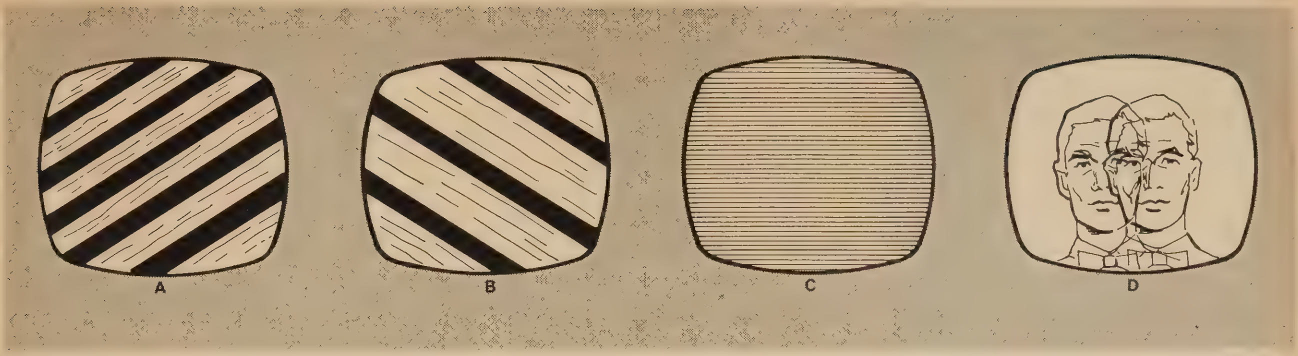


Fig. 2—What you'll see on the screen if the horizontal oscillator is running off frequency. a—Oscillator running too slow (frequency too low). b—Too fast. c—Way off frequency—the many fine lines can slant either way. d—Double image means either half-speed or double-speed—it's often hard to tell.

diodes in the afc, or look for bad resistors or leaky capacitors.

The synchroguide

The synchroguide (Fig. 4) is another popular circuit. This is a blocking oscillator, a stabilizing coil and afc, just like the rest. You can always identify it by the characteristic "lazy-T" shape of the coils.

Treat it just like the others. Take off the afc by grounding the grid of the afc section of the tube. Short out the stabilization by shorting the sine-wave coil (A to B in Fig. 4). Now, make it work. It will. There's always a frequency adjustment in this circuit—the "frequency coil" core. Adjust this until you get the single floating picture. If you can't, check the few remaining parts, the voltages and, finally, the coil itself.

Put the sine-wave coil back in by unshorting it, and adjust its core. Here we can use the scope to good advantage; this circuit always works better when set up with the scope. Hook a low-capacitance probe to point A (Fig. 4). Better still, just put the probe tip close to point A and turn up the vertical gain. You can get the same pattern, and the probe capacitance won't upset the circuit. Look for the characteristic hump-and-spike waveform, as in Fig. 4. We adjust this with the core of the sine-wave coil; this changes the phase of the added sine wave. Set it up so that the spike is just a wee bit above the hump. Works better that way.

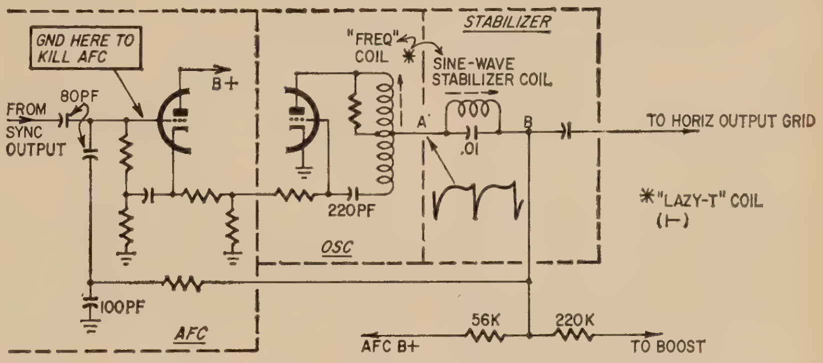


Fig. 4—Synchroguide circuit. Not too different from the rest. Again, sections are separated by dashed lines.

A few other things while we're talking about synchroguides. Note the two resistors connected to point B. These feed the plate voltage to the oscillator. The values given are typical of what you'll find. The 56,000-ohm goes to B-plus and is a "starter" resistor, to give the oscillator some plate voltage until the horizontal output stage warms up and the boost voltage can take over through the 220,000-ohm resistor. If the oscillator is slow-starting, check the 56,000-ohm resistor. If it has increased in value, the plate voltage will be low and the oscillator will start hard.

If both coils are in the same can, you won't have trouble identifying the adjustment screws: short out the sine-wave coil, then turn both screws. The one that has *no effect* on the picture is the sine-wave coil's core.

Always check the phase detectors, all tubes and all resistors and capacitors in any case of oscillator trouble. Also check all electrolytic capacitors on the B-plus feed lines. A slightly low-capacitance electrolytic can permit feedback and cause all kinds of weird results! Take your time, check out each part of the circuit, and horizontal oscillators won't give you trouble! END

Fig. 3—Uncontrolled oscillator that's running properly at the right frequency should make a single, distinct picture, like this. It will drift from side to side.

AN ALL-TRANSISTOR ELECTRONIC SWITCH

Useful tool for research or repair puts two simultaneous traces on any ordinary scope

By LEONARD J. D'AIRO

AN ELECTRONIC SWITCH IS A DEVICE that switches electronically between two separate input signals and presents them individually and simultaneously at a single output. Although simultaneous display of two separate waveshapes is usually reserved for complex dual-beam oscilloscopes, an electronic switch can make almost any single-beam show a simultaneous display.

The switch solves a major problem in servicing electronic equipment: simultaneous analysis of two separate signals on the screen of a scope, such as measuring phase shift or distortion in filters and networks of audio systems.

An electronic switch consists of two separate input signal amplifiers, a mixer and a free-running multivibrator. Signals are applied to the amplifiers and then to the mixer. The multivibrator output is also applied to the mixer to turn on first one section, then the other. Thus first one and then the other signal appears at the mixer output. With the multivibrator switching at a rapid rate, you get the illusion of two separate and distinct waveshapes appearing simultaneously on the scope screen.

The block diagram (Fig. 1) shows how the switch works. The signals to be analyzed are applied to the input amplifiers. Their outputs are fed to the mixer, where they are combined with signals from the multivibrator and shaper, then fed through the emitter follower to the oscilloscope.

Circuit description

Eleven transistors, all type 2N404, are used in the switch. Two 9-volt mercury batteries connected in series supply power. Where continuous use is necessary, external power should be used. The switch will operate from an external supply with two additional transistors connected in a series voltage regulator circuit so that any voltage between 18 and 25 may be used. The regulator also protects the equipment from any high-voltage transients in the ac line. Total power consumption of the switch is 360 mw (20 ma at 18 volts). The complete schematic is shown in Fig. 2.

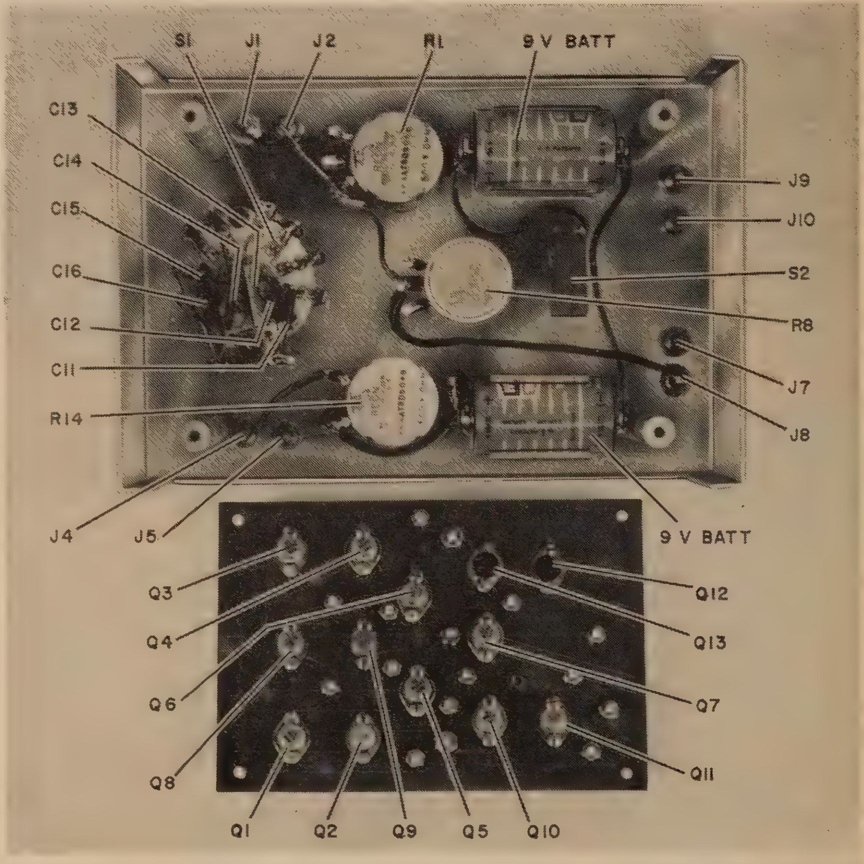
The input amplifiers for each channel (Q1, Q2 and Q3, Q4) consist of an emitter follower and a low-level high-gain amplifier. The input resistance of the emitter follower is about 0.5 megohm and should have no noticeable effect upon circuits tested. This high input resistance is due to the resistance-multiplying "bootstrap" circuit. The base resistor is returned to the emitter instead of to ground. This keeps the input resistance constant over a wide frequency range. R1 and R14 are channel gain controls, used to adjust the input signal level to the amplifiers.

The two amplifier outputs are ap-

BENCH TESTED

One of Radio-Electronics' editors tested the electronic switch and wrote: "The unit performs nicely. I connected it to my scope and fed it inputs from two audio generators—one sine-wave, the other square-wave. Both traces appeared on the scope screen and were clearly separated. All in all, the unit performed as specified.

"One minor fault: at one point in the gain controls' range, they jump very suddenly over what appears to be a considerable range and the scope input attenuator must be adjusted to compensate."



Layout of major parts inside case, and of transistors on copper laminate board. Nearly all wiring can be done before board goes into box.

plied to the bases of the two mixer transistors, Q5 and Q6. Resistors R8 through R12 are the base biasing resistors. R8 is the centering control, used to position the two traces on the scope screen. The collectors of Q5 and Q6 are tied together so that mixing takes place. The collectors are also connected to the base of an emitter follower, Q7. The output resistance of Q7 is low so that there is no loss or distortion of the signal between it and the scope. R13 in the base circuit applies proper operating bias to Q7. Sync output signals for each channel are obtained from the output of each amplifier.

Switching pulses are generated by a free-running multivibrator, Q8 and Q9. The circuit is typical except that transistor Q9 is more heavily biased than Q8 for easier starting at the higher frequencies. Capacitors C11 through C16 determine the basic switching rate of the

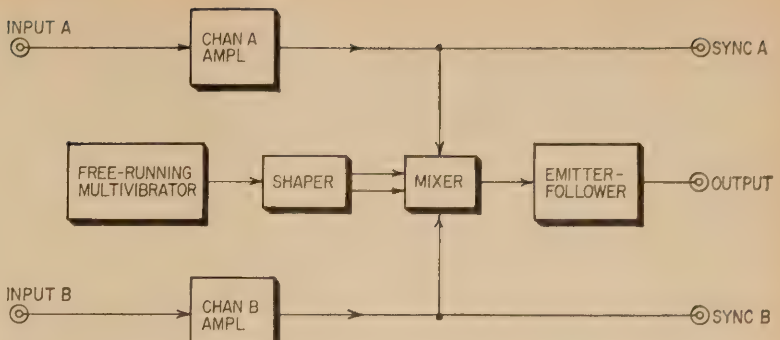

INPUT A
CHAN A AMPL
SYNC A
FREE-RUNNING MULTIVIBRATOR
SHAPER
MIXER
EMITTER-FOLLOWER
OUTPUT
INPUT B
CHAN B AMPL
SYNC B

Fig. 1—Block diagram of electronic switch. Inputs A and B are sampled at rate determined by multivibrator frequency.

C1, C6—10 µf, 25 volts, subminiature electrolytic
C2, C4, C5, C7, C8, C10—50 µf, 25 volts, subminiature electrolytic
C3, C9—.01 µf subminiature ceramic
C11, C12, C13, C14, C15, C16—capacitors as required—see text
C17, C18—220 pf mica
C19, C20—68 pf ceramic
D1, D2, D3, D4—1N295 (G-E)
D5—6.8-V, 1-watt Zener diode
J1, J2, J3, J4, J5, J6, J7, J8—tip jacks
Q1-Q13—all transistors 2N404 (Raytheon, G-E, RCA)
R1, R14—pot, 500,000 ohms, linear taper (IRC Q11-133 or equivalent)
R2, R15—510,000 ohms
R3, R16—39,000 ohms
R4, R6, R13, R17, R19, R26—10,000 ohms
R5, R18—470,000 ohms
R7, R20, R21, R22, R24, R28, R30, R34—6,800 ohms
R8—pot, 10,000 ohms, linear taper (IRC Q11-116 or equivalent)
R9, R10, R32, R36—15,000 ohms
R11, R12—47,000 ohms
R23—5,100 ohms
R25, R27—68,000 ohms
R29, R35—3,300 ohms
R37—6,200 ohms
R38, R40—3,300 ohms, 10%
R39—1,500 ohms, 10%
All resistors ½ watt, 5% except as marked
S1—rotary switch, 2 poles, 3 positions (Mallory 3223J or equivalent)
S2—toggle switch, spst
Aluminum 2-piece box, 5 x 7 x 3 in. (Bud 3008A, 2108A or equivalent)
Circuit board, standoffs, sockets, miscellaneous hardware

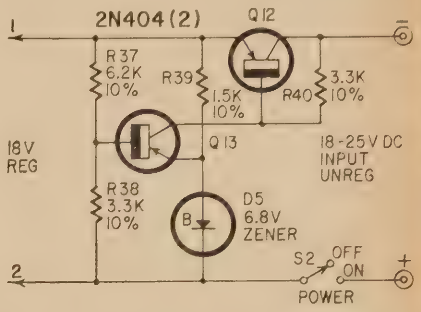
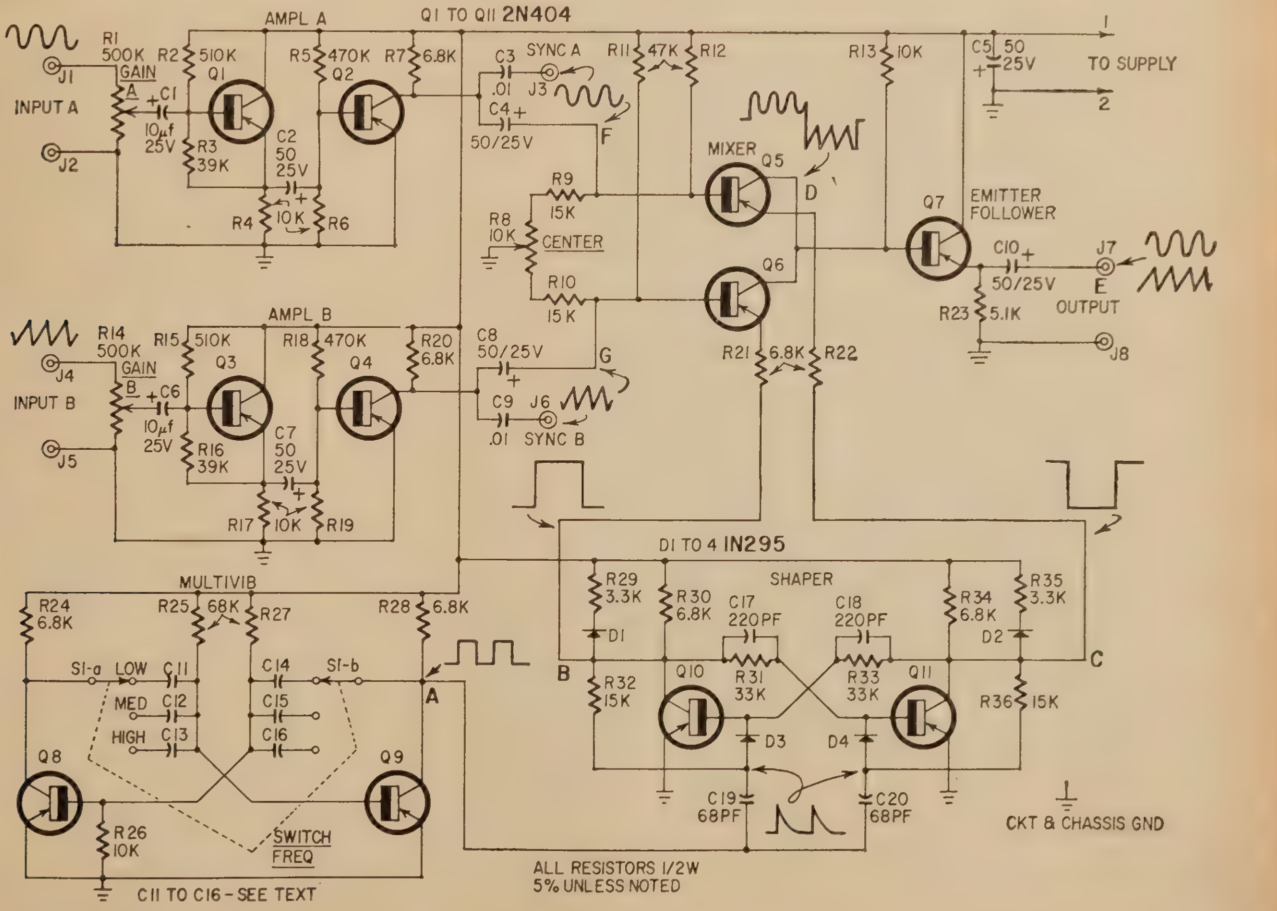

2N404(2)
Q12
1
R37
6.2K
10%
R39
1.5K
10%
R40
3.3K
10%
Q13
18V REG
18-25V DC INPUT UNREG
R38
3.3K
10%
D5
6.8V ZENER
B
2
S2
OFF
ON
+
POWER

Fig. 2—Complete schematic of the electronic switch, below, with power supply (above). For battery power, connect two heavy-duty 9-volt mercury batteries in series to points 1 and 2. Include switch S2.


AMPL A
Q1 TO Q11 2N404
R1 500K
GAIN
A
R2 510K
Q1
C1
10µf 25V
J1
INPUT A
J2
R3 39K
C2 50 25V
R4 10K R6
R5 470K
Q2
R7 6.8K
C3 .01
SYNC A
J3
C4 50/25V
F
R11 47K R12
R13 10K
C5 50 25V
1
TO SUPPLY
2
MIXER
Q5
D
R9 15K
R8 10K CENTER
R10 15K
Q6
Q7
EMITTER FOLLOWER
C10 50/25V
J7
E
OUTPUT
R23 5.1K
J8
AMPL B
R14 500K
GAIN
B
J4
INPUT B
J5
R15 510K
Q3
C6
10µf 25V
R16 39K
C7 50 25V
R17 10K R19
R18 470K
Q4
R20 6.8K
C8 50/25V
G
C9 .01
J6
SYNC B
R21 6.8K R22
D1 TO 4 IN295
SHAPER
MULTIVIB
R24 6.8K
R25 68K R27
R28 6.8K
S1-a LOW C11
MED C12
HIGH C13
C14 S1-b
C15
C16
A
Q8
Q9
R26 10K
SWITCH FREQ
C11 TO C16 - SEE TEXT
R29 3.3K
D1
B
R30 6.8K
C17 220PF
C18 220PF
R34 6.8K
R35 3.3K
D2
C
R32 15K
Q10
R31 33K
R33 33K
Q11
R36 15K
D3
D4
C19 68PF
C20 68PF
CKT & CHASSIS GND
ALL RESISTORS 1/2W 5% UNLESS NOTED

multivibrator. Various switching rates are obtained by changing the value of these capacitors with switch S1. The values depend on your requirements. They may be determined by the formula $C = T/R$, where C is the capacitance in farads, T is the time in seconds (converted from frequency; e.g., 1,000 cps = .001 second), and R is resistance in ohms. R in this case is 68,000 ohms (R25, R27).

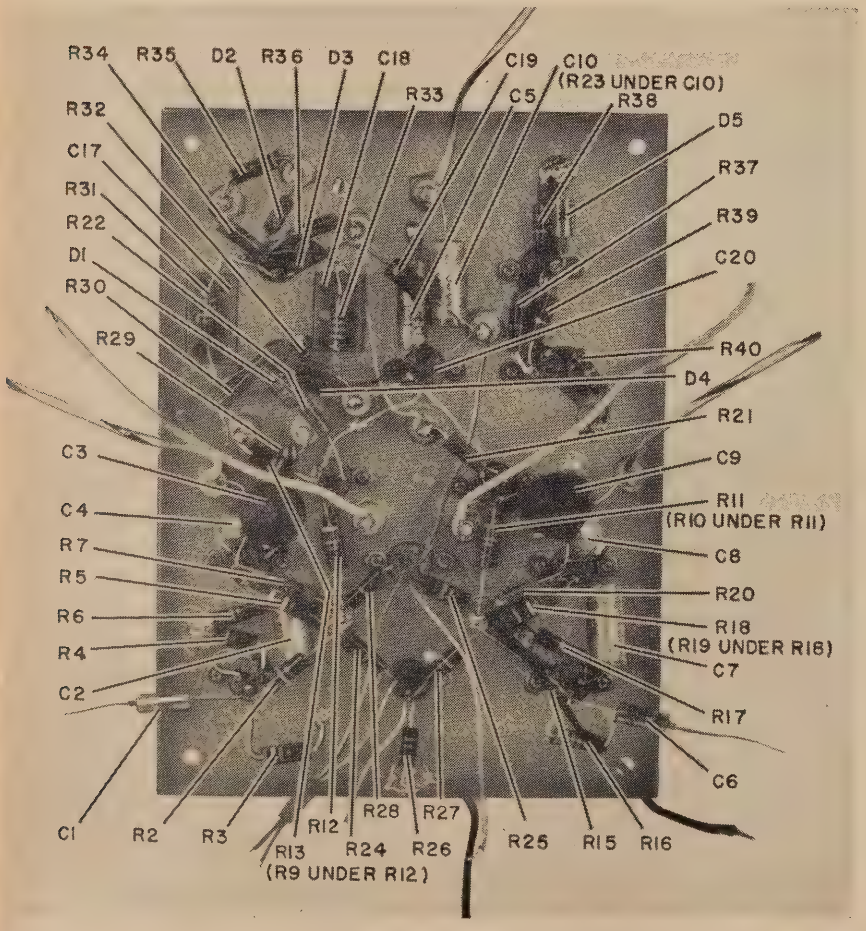
The multivibrator output drives a shaper circuit, actually a bistable multivibrator (flip-flop). This shaper increases the rise and fall times of the pulses so that the input signals are reproduced exactly. D1 and D2 are "speed-up" diodes, used to increase the pulse rise time at high switching frequencies. D3 and D4 are "pulse-steering" diodes. They allow only the positive half of the driving pulses to trigger the transistors. Diodes D3 and D4 are not necessary, but when they are not used, more driving power is required to trigger the shaper and it will not operate at the higher frequencies.

Since the shaper is a flip-flop circuit, it divides by two the pulses applied to it. That is, for every two pulses applied, only one pulse comes out. Therefore, if a switching speed of 10 kc is required, the multivibrator must provide a 20-kc switching pulse. This must be taken into consideration when calculating for capacitors C11 to C16.

The emitters of mixer transistors Q5 and Q6 are connected through R21 and R22 to the collectors of Q10 and Q11 of the shaper. Following the switching action, when Q11 is conducting, current flowing through R34 causes a voltage drop across it. This places the collector of Q11 at a positive potential. Since the emitter of Q5 is connected to the collector of Q11, it now becomes more positive than its collector and causes the transistor to conduct. The signal applied to the base is now amplified and appears at the collector. The same action occurs with Q6 and Q10 when Q10 conducts.

SPECIFICATIONS OF THE ELECTRONIC SWITCH

Frequency response: ± 2 db to 3.5 mc
Input resistance: 500,000 ohms
Output resistance: 500 ohms
Input level: 3 mv to 20 v
Crosstalk: —1 db at 1 mc
—20 db at 3.5 mc
Power consumption: 360 mw



Wiring details of circuit board. Ground connections are soldered direct to copper surface. Sockets provide tie points, reduce chances of heat-damaging transistors.

As Q10 and Q11 switch alternately between conduction and cutoff, Q5 and Q6 also switch alternately. Signals applied to their bases appear alternately at the output. Because of the switching rate and sweep speed of the scope, the two signals appear simultaneously and independent of each other.

The series regulator consists of two 2N404 transistors, Q12 and Q13. Q12 is the regulator and Q13 the control transistor. Resistor R40 biases Q12 to conduction and is also the collector load for Q13. R39 is the Zener diode (D5) bias resistor; R37 and R38 are the base biasing resistors for Q13. Resistor R37 is also used as a "sensing resistor". That is, it "senses" any changes in otuput voltage so that it will vary the bias on the base of Q13. Variations in base bias cause Q13 to swing between conduction and cutoff.

Since the collector of Q13 is connected to the base of Q12, as Q13 conducts Q12 tends to cut off. As Q13 cuts off, Q12 conducts heavily. This way the output is held practically constant over a wide range of input voltage. The point at which Q13 cuts off or conducts is set by the value of emitter voltage, which, as a reference, must be well regulated—hence the Zener diode, D5.

Construction

The electronic switch, series regulator and battery supply are built into a 5 x 7 x 3-inch aluminum Minibox. All components except the controls, jacks and batteries are mounted on a copper laminate board which is the chassis. The board is mounted to the Minibox and supported by four 2-inch ceramic standoff insulators.

All leads must be kept as short as possible to prevent interaction between circuits. Sockets are used for all transistors. All circuit grounds are made direct to the copper laminate. Layout is not particularly critical. Any arrangement can be made, provided precautions are taken against unwanted coupling.

The batteries are held in place by plated beryllium-copper clips mounted on the front panel so that they will not interfere with components or circuitry. After construction, check all wiring.

Operational test

With the batteries in place, insert transistors Q8 and Q9 in their sockets. Connect the vertical input leads of a scope between ground and point A (Fig. 2) of the multivibrator and apply power. You should see a rectangular waveform similar to the one shown. Switch S1 to check proper operation of the multivibrator at different frequencies.

Next, insert transistors Q10 and Q11 in their sockets. Connect the leads first to point B and ground and then to point C and ground, and compare waveshapes. To be certain that the shaper is operating properly, connect the oscilloscope lead to point A again and adjust the scope sweep so that 10 pulses appear on the screen. Connect again to points B and C. Five pulses should be seen at each point. Repeat this procedure for each switching frequency.

After the multivibrator and shaper are checked out, insert the remaining transistors in the sockets in this order: Q5, Q6, Q7, Q1, Q2, Q3 and 4, testing each point in the alphabetical order shown in Fig. 2. Before Q1, Q2, Q3 and Q4 are inserted, the scope lead should be connected to point E and the centering control (R8) varied. The two straight-line traces on the screen should be separated at the extreme clockwise and counterclockwise positions, and should merge at the approximate mid-position of the control. Test the remaining points.

When all circuits and stages are operating properly, apply two different signals to INPUT A and INPUT B. Two separate waveshapes—exact reproductions of the input signals—should appear simultaneously at point E. Vary the centering control. The two traces should vary in separation, merge and change position. As the control is varied, the amplitudes of the viewed signals should not change. If they do, interchange transistors until there are no longer any amplitude variations.

In using the electronic switch with a scope, use the dc position of the vertical amplifier. If the scope has none, and the ac input must be used, make certain that the input capacitor of the scope is at least 1 μf (paper) and the coupling capacitors between stages are from 0.1 to 0.25 μf. Other values will cause switching transients (peaking and spikes) to appear on the screen. These transients will distort the viewed waveshapes (this holds true with any type of electronic switch). END

"No 12SN7, Dear, How about two 6SN7's instead?"

Tricky Transformer Troubles

By E. C. CARLSON

THE SOURCE OF AN ANNOYING TICKING sound in a built-in hi-fi installation was isolated to the output stage. Tube changing normalized operation for only a few minutes. At this point, accidental hand pressure on the top of the output transformer stopped the 1-second spaced ticks. A screwdriver grounding the painted pressed-steel case had no effect. The final solution was to dent the top of the case several times with the round end of a ball-peen hammer. After two years, the noise has not returned.

The cause can only be guessed at. It would seem that one of the internal shields, or the core itself, became ungrounded (Fig. 1). Being physically close to the output transformer primary winding, it was charged by the B-plus voltage applied to the output stage through a high-resistance leakage path. At some point the voltage was high enough to arc over (causing the tick). The ungrounded internal shield can was, in effect, a capacitor in series with the high-resistance leakage path (Fig. 2), which limited the charging current. When the charge across the gap was high enough an arc occurred, discharging the capacitance. The cycle then repeated itself. Note the similarity to the more usual relaxation oscillator circuit in Fig. 3. Here the neon lamp is the "spark gap" which reduces the capacitor's charge. Apparently the hammer taps renewed the ground contact, shorting the capacitor and the spark gap.

A more common transformer fault is lamination hum in power transformers. To reduce or eliminate this noise, the first thing to do is check for loose assembly screws. These should be tight, but be careful. Too much heft with a sturdy screwdriver and an open-end wrench can strip the threads or break the machine screw.

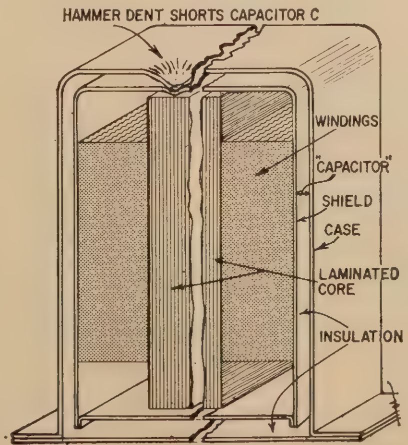


Fig.1

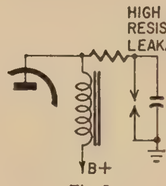


Fig.2

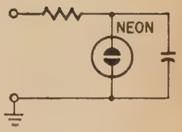


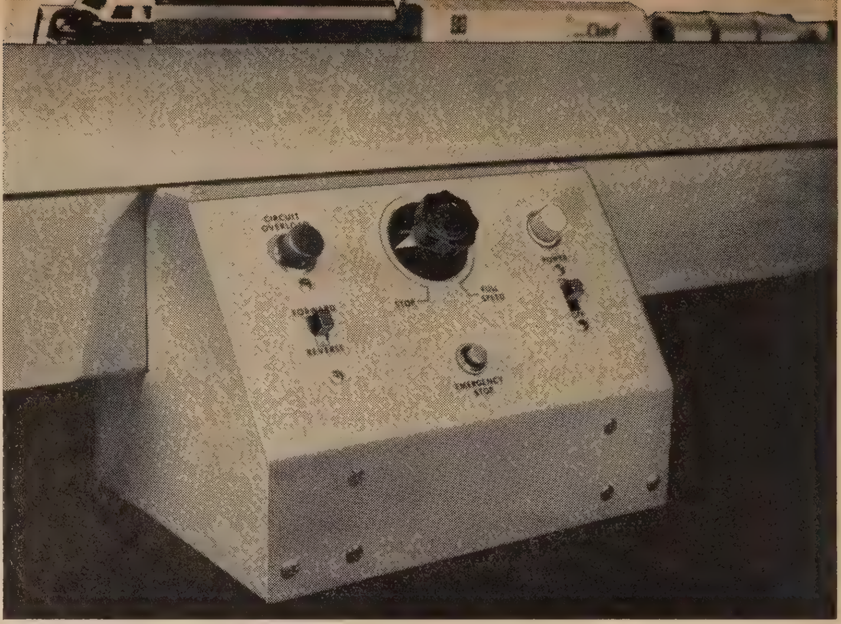
Fig.3

At this point the normal quieting technique would be to loosen all the machine screws and apply a coating of thin varnish to the lamination edges. Capillary action will draw it between the flat surfaces of the core laminations. When the varnish has become tacky, compress the laminations by tightening the mounting screws. Drying time can be decreased by operating the equipment.

A quick field repair, or if the varnish doesn't stop the hum, is with hammer again. Remove the mounting nuts of the transformer and isolate it mechanically from the chassis. It is not necessary to remove any soldered connections. If the chassis is small and has no interfering or delicate parts, just remove the tubes. Several blows with a hammer on the lamination edges on each of the sides of the transformer usually spread the metal enough to stop the vibrations. Hammer blows that do not land flush upset the metal edges more drastically. The round head of a ball-peen hammer works fine here too.

This cure also works on noisy fluorescent lamp ballasts. For safety, the ballast *must* be removed from the fixture. Hammer dents can be along the bottom of the ballast case, making the repair almost invisible. This is recommended not only as a last resort—even new ballasts may start to buzz after a few weeks' operation.

Lamination hum is not always a nuisance. It has been put to use as a current indicator. A blind amateur radio operator has used the hum as an audible indicator while tuning the rf power amplifier. Minimum hum occurs when minimum current flows. The amplifier is properly tuned when the hum is lowest. END



Transistor Speed Control For HO Railroaders

Regulated dc supply uses small potentiometer to control trains realistically from a crawl to a whiz

By TOMMY N. TYLER

PEP UP THE FUN OF AN HO-GAUGE MODel railroad for yourself or your youngster by adding this simple transistor speed control to the layout. It simulates the "feel" and momentum of a big locomotive—very realistic starting, coasting and braking effects, all automatic. There's a variety of automatic and remote-control features you can add.

Most moderately-priced speed-control power packs for HO model railroading fail to provide realistic starts or stops because of the abrupt way the speed is controlled. Most HO-gauge power supplies deliver about 16 to 18 volts dc at no load, dropping off to about 12 volts at 2 to 4 amps, depending on the rating of the supply. Usually the output is split between a fixed supply for operating switches and other accessories, and a variable supply for controlling the speed of the train. The typical motor in a medium-sized engine has a dc resistance of about 6 ohms and draws 0.5 amp maximum.

Nearly all HO locomotives use permanent-magnet dc motors whose speed is almost directly proportional to applied voltage, for a constant load. When a voltage is first applied to the motor, it draws a maximum "stall" current limited only by the dc resistance of the armature windings. As speed picks up, the current decreases due to back-emf until the motor speed stabilizes.

The most common type of speed control is a variable transformer with a slider that moves across the secondary windings and taps off a voltage proportional to the position of the speed-control knob or lever. The output is usually full-wave-rectified without any filtering. Frequently a switch marked "pulse power" is on the power pack. This simply disconnects one of the rectifiers so that the output is only half-wave-rectified. The resulting 60-cycle pulses vibrate the armature to loosen bearing and brush friction so that the locomotive can start smoothly and run extremely slowly.

Another widely used type of speed control has a rheostat to vary the full-wave rectified voltage applied to the tracks. A typical unit might use a 40-ohm rheostat, often with a tapered resistance element, rated at 50 to 100 watts. This type of control provides poor speed regulation under varying load conditions. When the train starts uphill, the increased current demanded by the motor causes an increased voltage drop across the rheostat, with the result that the train slows down and may even stall. Conversely, when the train starts downhill, it tends to "run away." The only solution is to keep readjusting the throttle.

All aboard

Fig. 1 shows the basic circuit of the control. Potentiometer R1 is the "throttle". The heart of the circuit is the R-C time delay derived from R2 and C2. This delay causes the voltage applied to the base of Q1 to increase or decrease slowly to the level set by RI. As a result, the voltage applied to the tracks changes gradually even though the throttle is suddenly turned full-on or full-off. This causes the train to start up or come to a stop slowly, with the rate of acceleration or braking depending partly on how far the throttle is moved.

Transistors Q1 and Q2 are cascaded emitter followers used in a simple variable voltage supply. Q1 has a high input

C1—2,000 µf, electrolytic, 25 volts (Cornell-Dubilier FB-2520 or equivalent)
C2—150 µf, electrolytic, 15 volts (Cornell-Dubilier 150-15 or equivalent)
D1, D2, D3, D4—silicon rectifier, 50 piv, 3.5 amps (1N3569 or equivalent)
F—fuse, ½ amp
I1—12-volt pilot lamp, (No. 1892 or similar) and socket
I2—No. 1073 auto lamp, single-contact bayonet candelabra socket (Allied Radio stock No. 52 E 857)
Q1—Small-signal germanium p-n-p transistor, 100-mw dissipation, 20 volts V_{CE}, h_{FE} 50 or greater (2N1370 or similar)
Q2—Germanium p-n-p power transistor, 3-amp I_c (Motorola 2N554 or similar)
R1—pot, 1,000 ohms, 1 watt, linear (Clarostat 43C1 or equivalent)
R2—33,000 ohms
R3, R5—100 ohms
R4—1,000 ohms
All fixed resistors ½ watt, 10% tolerance
RY—spdt relay, 12-volt dc coil
S1, S3—dpdt switch (slide or toggle)
S2—spst pushbutton switch
S4—4pdt switch (slide or toggle)
S5, S6—spst switch
T—filament transformer, 12.6 volts, 2.5 amps (Triad F-26X or equivalent)
Panel, housing, miscellaneous hardware.

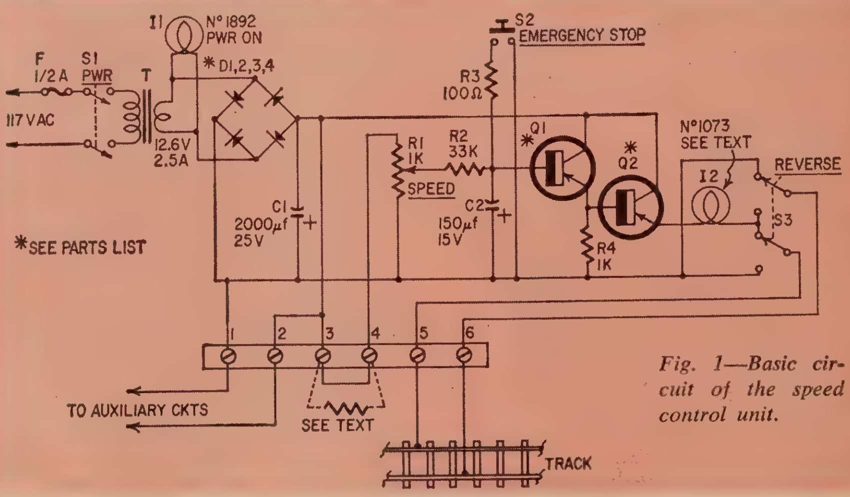


Fig. 1—Basic circuit of the speed control unit.

impedance to prevent loading the R-C timing circuit, while Q2 is a power output stage to supply the heavy current to the tracks. A wide variety of junkbox transistors may be substituted for the ones given. If a low-gain transistor is used for Q1, the input impedance of this stage will be reduced proportionately, and the loading effect on the R-C circuit may limit the output voltage at maximum throttle setting. One way to cure this is to reduce the value of R2 and use a correspondingly higher value of C2 to maintain the desired time constant.

The value given for R2 and C2 give a 5-second time constant. If the throttle is suddenly turned full-on, the locomotive reaches apparent maximum speed in about 12 seconds, which is a realistic effect. Shutting the throttle all the way off from full speed brings the train to a stop in about 12 seconds and 12 feet of track. Emergency-stop pushbutton switch S2 stops the train in a much shorter time, though not too abruptly.

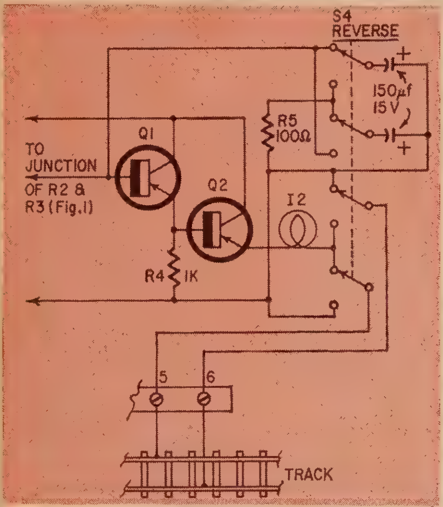


Fig. 2—Using a four-pole reversing switch and two timing capacitors prevents disastrous reversals while a train is moving.

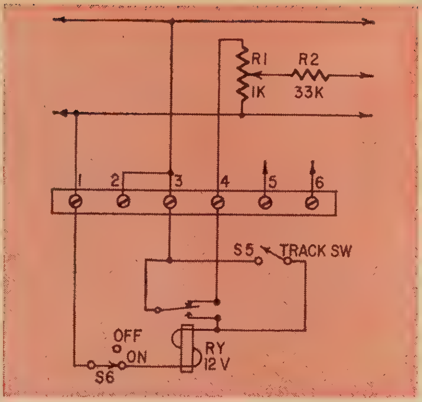


Fig. 3—Circuit for bringing train to a coasting stop when track switch is actuated.

A sort of "maximum-speed governor" can be included by inserting a resistor (dotted lines in Fig. 1) before the throttle to limit the maximum voltage applied to Q1. This is a handy feature for preventing the youngsters from derailing the train by operating at excessive speeds. Determine the value of this resistor by experiment.

With the circuit shown in Fig. 1, flipping reversing switch S3 instantly reverses the track polarity. If a long train is rounding a curve at high speed when this is done, the results can be catastrophic! Using a four-pole reversing switch as shown in Fig. 2 eliminates the problem. In this circuit, two timing capacitors are used, one for forward and one for reverse. The capacitor not in use is kept discharged by R5. When switch S4 is reversed, track voltage drops instantly to zero, then increases slowly as the new capacitor charges up. The train will stop quickly, then gradually resume speed in the opposite direction.

Fig. 3 shows a way to provide realistic automatic stops at stations, loading docks, etc. S5 is a track-operated switch, which is placed about 12 feet ahead of where you want to stop the train. When the train closes S5 momentarily, relay RY locks itself on and disconnects the upper end of the throttle. C2 immediately starts discharging through R1 and R2, bringing the train to a gradual stop. When S6 is switched off, the train will resume speed.

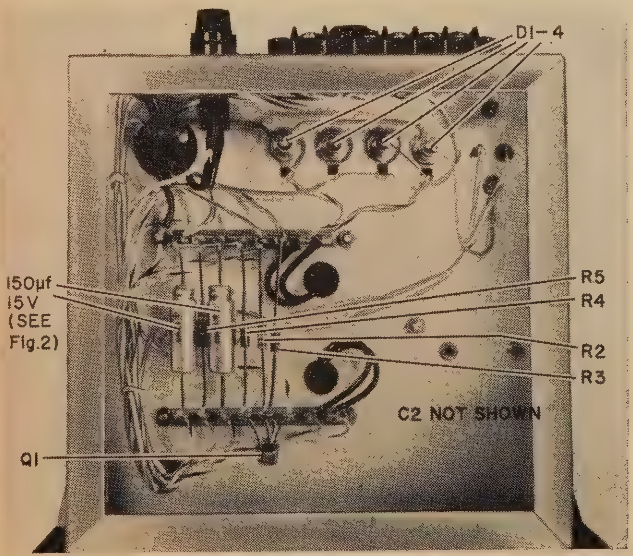
In the circuits shown, a No. 1073 automotive lamp bulb (readily purchased at any gas station) has been used in place of a circuit breaker. The lamp acts as a current limiter due to the positive resistance–temperature coefficient of the tungsten filament. The lamp has a cold resistance of about 1.2 ohms. Its resistance is 7.1 ohms at its rated 12.8 volts and 1.8 amps. Under normal operating currents up to 0.5 amp, the lamp has practically no effect but, if the track is short-circuited, the current is limited to a safe value of about 1.7 amps. Since the lamp glows brightly when the track is shorted, it serves as a handy overload indicator, mounted behind a jewel on the panel.

Last stop

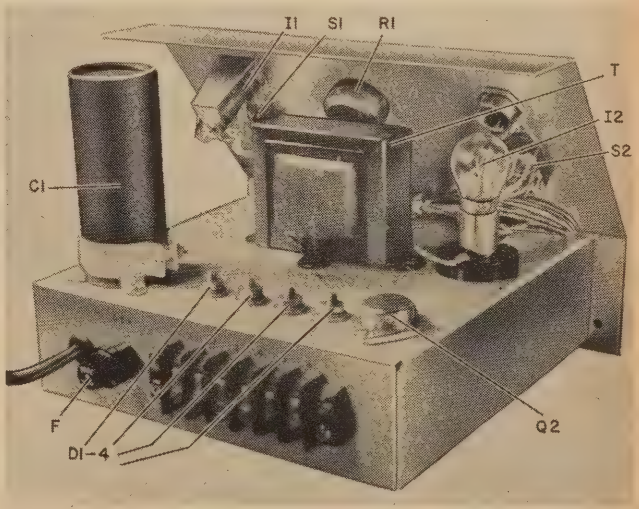
The unit illustrated was constructed on a 7 x 7-inch chassis attached to a sloping front panel. Wooden sides were used to make it easy to screw the unit to the edge of a train table, and to save the cost of a sloping-front cabinet.

Two parallel terminal strips were used under the chassis to mount the small components. The power transistor is mounted directly to the chassis for a heat sink. The rectifiers are mounted beneath the chassis with insulating washers and sleeves.

Mount the socket for I2 on the chassis so that the lamp filament is directly behind the pilot light jewel on the front panel. None of the wiring or component placement is critical. Be sure to use a cover over the underside of the chassis if it is exposed. END



Underneath the chassis.



Four diodes and transistor Q2 are all "heat-sunk" together along back of chassis.

BATTERIES IN RIBBONS

Dry-tape batteries reel off only the power you need at the moment, would have indefinite shelf life and many other advantages.

By ERIC LESLIE

THE DEVICE ON OUR COVER IS UNQUESTIONABLY a tape machine. But it is a tape machine that produces electricity—actually a new type of primary cell. "The fuel-cell people may not think it a fuel cell, and the battery people may not consider it a battery," but under whichever name it goes, it is a new form of electrochemical energy conversion system, and may have important advantages in certain applications.

Just what is this fuel cell/battery? It differs from the ordinary cell chiefly in that the active elements are all "on tape". Fig. 1 shows a simple type of tape battery. The tape base may be an ion-exchange membrane or porous separator. On one side of the tape, we have the anode material, on the other, the cathode material. The electrolyte is encapsulated in micropellets and may be contained in either or both coatings. The tape may be wound on a supply spool, as shown at the right in Fig. 1. The "capstan" of this machine actually consists of a pair of rolls which crush the tape and release the electrolyte. The tape then passes between the current collectors while the electrochemical reaction is going on. The used-up tape is wound on a takeup reel, from which it can be disposed of. The speed may be about one inch per minute.

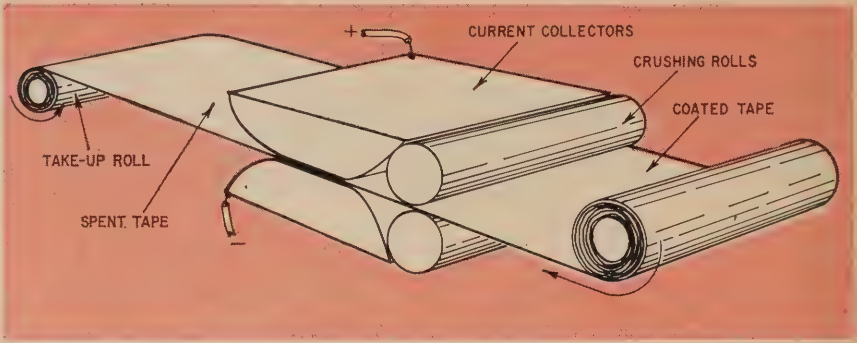
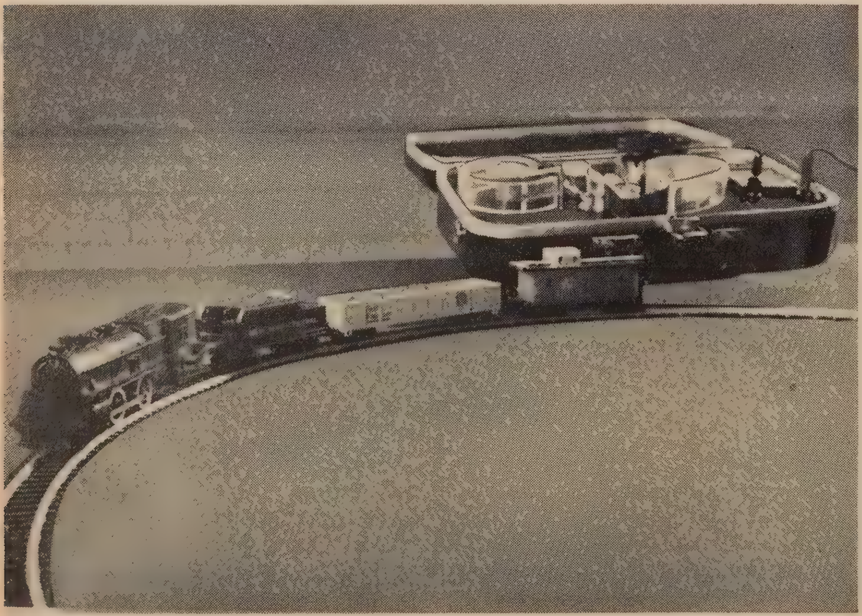


Fig. 1—General tape battery scheme. Active elements including encapsulated electrolyte are part of tape. Rolls crush electrolyte capsules, freeing liquid and beginning chemical action.

A number of experimental models have been made by the developers, Monsanto Research of Everett, Mass., so that a general description may not exactly fit any one of the various models. The fundamental principles are the same in all of them, however. One of the earlier models uses silver peroxide and zinc with a potassium hydroxide electrolyte. The silver peroxide is reduced to finely divided metallic silver on the tape to produce current.

Experiments are also being made on a battery using magnesium and meta-dinitrobenzene, with magnesium perchlorate as the electrolyte. Such a battery would have a much higher output per pound of battery than the zinc–silver–peroxide type. The tape of such a cell is shown in Fig. 2. The total thickness would be 5 to 10 thousandths of an inch.

Tape battery (rear right) furnishes power for the model railroad train.



Why a tape battery?

But why go to all this trouble to produce a battery? Highly efficient dry cells can be made, and it would seem that with its driving machinery, tape reels, etc., that this battery would be neither compact nor efficient. What are its advantages?

The first great advantage is the tremendous gain in watt-hours per pound. Since the collectors can handle an infinite length of tape, we do not need the heavy collector structure (plates, etc.) found in present high-rate batteries. Since the active part of the elements consists only of the small piece of the tape between the collectors at any given time, the design can be highly efficient.

Closeup of one of the prototype tape batteries.

Another important feature is that the portion of the battery not being used to produce current at the instant is stored in an inactive state and can remain that way for an indefinite time. Internal resistance can be low and output voltage steady. The problem of separator shorting does not arise. When the battery is switched off, the elements (except for a small portion between the collectors) are out-of-circuit and not subject to local action. When the battery is dead, all that needs replacing is the light tape. In some applications, simplification of transportation and storage problems is important.

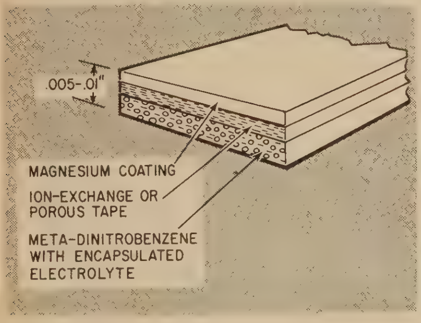

.005-.01"
MAGNESIUM COATING
ION-EXCHANGE OR POROUS TAPE
META-DINITROBENZENE WITH ENCAPSULATED ELECTROLYTE

Fig. 2—Cross-section of magnesium/meta-dinitrobenzene tape battery.

It might be urged against the battery that part of its output had to be used to drive it. However, the power required to pull tape in the experimental devices has been measured at 50 milliwatts while the cell was producing 1,300 mw.

The prototype silver–zinc cell has an open-circuit voltage of 1.86, and a voltage of 1.4 while supplying current at a density of one ampere per square inch. The drop due to internal resistance is estimated at about 0.1 volt. Monsanto researchers state that with current density of 1 ampere per square inch at the collector, the cathode utilization of the cell is 90% of the theoretical value. The corresponding performance of the conventional silver–zinc primary cell is about 20%, the researchers say.

In the experimental silver–zinc tape battery, an experimental capacity of 75 watt-hours per pound has been obtained, although the theoretical limit is 90 watt-hours per pound. A Le Clanché battery (ordinary dry cell) checks out at an experimental capacity of 35 watt-hours per pound, and an estimated theoretical maximum of 70 watt-hours per pound. The magnesium meta-dinitrobenzene system is expected to have a possible watt-hour capacity of 245 per pound.

Still other forms?

The equipment is still in the early experimental stage, and numerous variations appear. For instance, in one type, two tapes are used: one carrying the silver peroxide coating and the other a potassium hydroxide solution as an electrolyte. A stationary zinc plate acts as both anode and collector. The two tapes are brought together just before reaching this plate, and the potassium hydroxide soaks through the tape to the silver peroxide. In this type of device, the tape containing the electrolyte must be stored in a sealed container before use.

It was suggested also that instead of encapsulating the electrolyte in microgranules in the tape, larger pods of electrolyte might be used, situated along the edge of the tape and forced into contact with the anode and cathode by the crushing rolls, something like the developer in the Land camera.

The battery is being developed by Monsanto under a contract with the National Aeronautics and Space Administration (NASA). The high energy density-to-weight ratio may make the device valuable in a number of applications, such as space vehicle power sources, in which present batteries have many disadvantages. END

TOO MUCH AFC? MAKE IT VARIABLE

By J. T. SAMUELSON

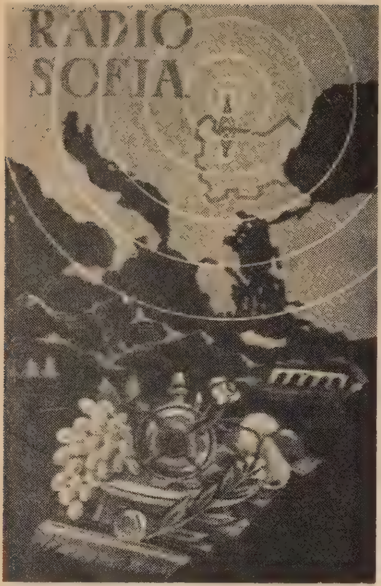
UNTIL I INSTALLED AN FM TUNER IN my car I never thought there could be *too much* afc in an FM tuner. I had heard of variable afc, but couldn't quite see the necessity. But my Heathkit GR-41 FM auto radio was so sensitive and the afc so strong that during any momentary loss of signal due to fading, interference, multipath cancellations or any other cause, the afc would actually pull in an adjacent station and lock onto it. It would remain locked until *that* station faded, then it would snap back to the station to which it had been tuned. (The tuner was definitely not tuned *between* stations.)

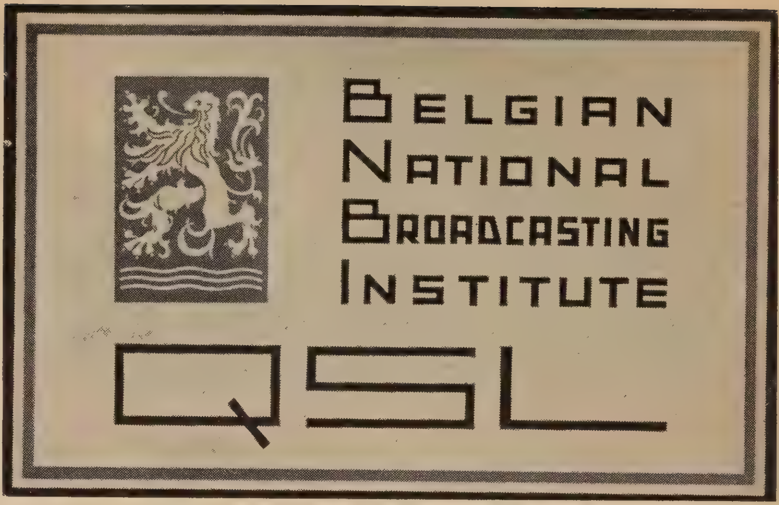
The afc in the Heath FM auto radio can be defeated, but the problem then is one of either feast or famine. With the afc defeated, tuning is critical and difficult in a moving automobile, but tuning without defeating the afc is rather difficult also. I found that, by tuning carefully to a strong station with the afc defeated and then switching the afc on, I could tune up or down the band more than 1 mc before the afc would unlock and pick up another station.

To reduce the afc voltage when the defeat switch was off, I tried various resistances across the open switch. With each value I checked the range over which the afc would track the station to which it was tuned: 100,000 ohms had very little effect and 10,000 allowed the afc to lock in a strong station over about 200 kc. This would be ideal except that weaker stations, where afc is needed more, were not "pulled in" as well as they were with about 33,000 ohms across the switch.

I decided that for the afc I wanted for all the variations in signal strength encountered in an automobile, I would need a continuously variable control. I found that a C.T.S. type 300 potentiometer would fit right in place of the switch in the Heathkit. I chose a 100,000-ohm pot, which allows me to defeat the afc completely or to increase it to almost the original level.

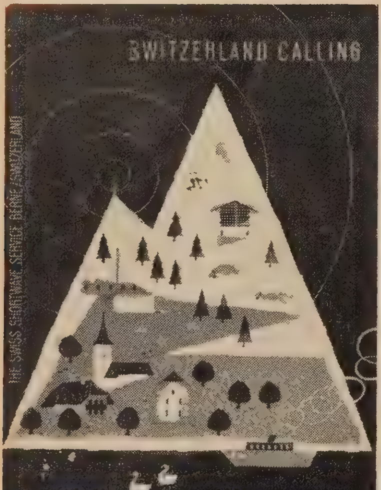
To tune, I turn the afc down (but not off). When the station is tuned in I turn up the afc. To listen to San Diego, almost 100 miles away, I keep the afc down so that the tuner doesn't jump to one of the Los Angeles stations 30 miles away. But, if I am tuned to a strong local station, I turn the afc full on to gain all the benefits it privides. END

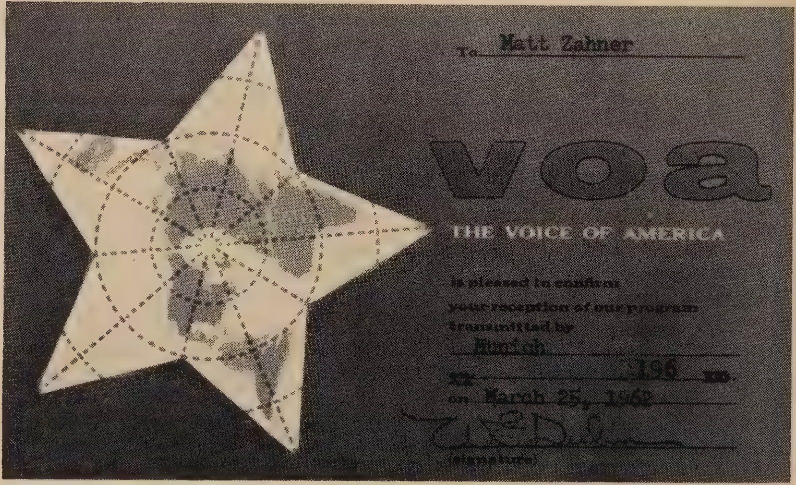

RADIO
SOFIA


BELGIAN
NATIONAL
BROADCASTING
INSTITUTE
QSL

Listen to Europe on Your Broadcast Radio

Not only Europeans, but North Africans and the occasional Asian are now coming in on the broadcast band

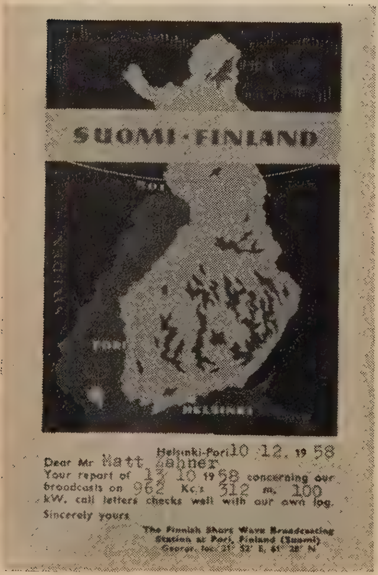

SWITZERLAND CALLING
THE SWISS SHORTWAVE SERVICE BERNE/SWITZERLAND


voa
THE VOICE OF AMERICA

To Matt Zahner

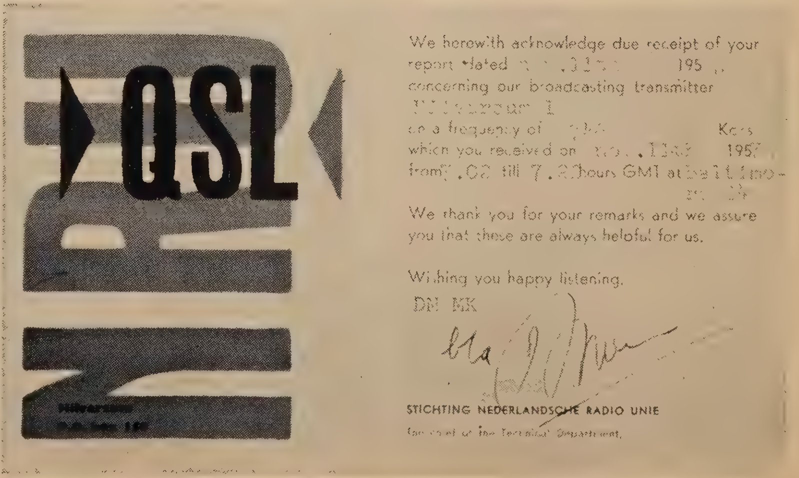
is pleased to confirm
your reception of our program
transmitted by
Munich
196
on March 25, 1962

(signature)


SUOMI-FINLAND
PORI
HELSINKI

Helsinki-Pori 10 12. 19 58
Dear Mr Matt Zahner
Your report of 13 10 19 58 concerning our broadcasts on 962 Kc:s 312 m. 100 kW. call letters checks well with our own log.
Sincerely yours

The Finnish Short Wave Broadcasting
Station at Pori, Finland (Suomi)
Geogr. loc. 21° 52' E, 61° 28' N


QSL
NRU
Hilversum

We herewith acknowledge due receipt of your report dated [illegible] 195
concerning our broadcasting transmitter
Hilversum I
on a frequency of [illegible] Kc/s
which you received on [illegible] 1957
from 7.02 till 7.20 hours GMT at [illegible]

We thank you for your remarks and we assure you that these are always helpful for us.

Wishing you happy listening.

DN MK

STICHTING NEDERLANDSCHE RADIO UNIE
for chief of the Technical Department.

TABLE I

Frequency (kc)	Station	Location	Power (kw)	Schedule*
584	RNE	Madrid, Spain	200	3:00 am–7:00 pm
647	BBC	Daventry, G.B.	150	1:40 am–6:45 pm
647	BBC	Crowborough, G.B.	150	10:45 pm–1:00 am (foreign languages)
665	——	Lisbon, Portugal	135	2:00 am–7:00 pm
755	——	Lisbon, Portugal	135	7:00 am–7:00 pm
764	——	Dakar, Senegal	200	
782	CSB9	Miramar, Portugal	100	2:00 am–8:30 pm
836	RTF	Nancy, France	150	Midnight–6:00 pm
845	——	Rome, Italy	150	24 hours daily
863	RTF	Paris, France	150	Midnight–6:00 pm
935	RTM	Rabat, Morocco	27	1:30 am–7:00 pm
944	RTF	Toulouse, France	100	Midnight–6:00 pm
1034	CSB2	Parede, Portugal	25	Midnight–7:00 pm
1205	RTF	Bordeaux, France	100	Midnight–6:00 pm
1214	BBC	10 Synchronized stations, G.B.	10-50 each	12:30 am–9:00 pm
1295	BBC	Crowborough, G.B.	150	11:00 pm–1:00 am (foreign languages)
1376	RTF	Lille, France	150	Midnight–6:00 pm
1466	3AM2	Monte Carlo, Monaco	400	12:30 am–8:00 pm
1538	——	Mainflingen, Germany	300	10:58 pm–7:10 pm
1554	RTF	Nice, France	60	Midnight–2:30 pm
1578	——	Lisbon, Portugal	10	2:00 am–9:00 pm
1586	——	Oldenburg, Germany	20	10:55 pm–7:15 pm

(G.B. = Great Britain)

*Schedule lists earliest sign-on and latest sign-off times. Some stations operate intermittently during their broadcast day but programs will be continuous during hours that they can be heard here.

Stations that can be heard on inexpensive equipment by dxers with little experience.

By MATT ZAHNER

MENTION DX AND THE AVERAGE LISTENER will think of the foreign shortwave stations he can hear on a normally unused band on his home radio. To receive European stations on the broadcast band is unthinkable! He does not realize that many European and North African stations are within his reach, and with careful tuning and an unlimited amount of patience, he will be able to hear them.

As most dxers know, long-distance radio reception depends on the ionosphere. During low sunspot activity, its density decreases. Signal strength on the broadcast band increases and distant stations which would otherwise not be heard are received.

The present sunspot cycle will bottom during this winter and experienced dxers are already receiving excellent trans-Atlantic signals. In the spring of 1965, the number of sunspots will begin to increase, but some observers believe that, even when they reach the peak in about 5 years, they may still be low enough to permit good reception from Europe on the broadcast band. During previous periods of low sunspot activity (1941–45 and 1953–55, for example) weak stations, not only in Europe, but in Australia and New Zealand were regularly logged in the United States. Many dxers on the East Coast reported one or more "Aussies" coming through. Oddly enough, much of this reception was on small five, six and seven-tube home radios.

The trans-Atlantic stations, especially those in Europe and Africa, transmit on frequencies 9 kilocycles apart. In North America, stations are 10 kilocycles apart. So the signals from European and African transmitters will usually be found in the "open" spaces between the domestic stations. If the broadcast-band dxer begins with the frequency of 548 kc and adds 9 kc to each frequency, he will have an idea of the location of these "split frequencies." Quite naturally, some European frequencies coincide with domestic channels, examples being 710, 800, 890, 1160 and 1500 kc.

What can be heard?

Two African stations now being received in the Eastern United States are Morocco on 935 and Senegal on 764 kc. Both were logged early in August 1964, although the best season of trans-Atlantic reception is North American winter. Unless a dxer is in an area where there is a powerful local broadcaster, he should have no trouble hearing these two strong outlets.

Located much closer to an American station, but just as strong, is the Portuguese outlet on 782 kc. This has been logged in Texas on moderately priced equipment. I have heard it on a car radio while driving a Maryland highway.

No magic formula is necessary to hear these and other foreign stations A good medium-priced radio, preferably with six or more tubes, can do the trick. Most communications receivers on the market today can pick up the stronger stations and separate them from adjacent domestic signals. It will take considerable digging down into the nois and interference unless the receiver is o fairly good design.

A wire antenna at least 100 feet i length will be excellent, although i close quarters, one of 25 to 50 feet wil suffice. Many broadcast-band dxers us a loop antenna. Most common is a 3 foot cross around which is wound 10 t 15 turns of wire. A loop antenna has tendency to null out a nearby interfer ing station if its position is well to on side of the line between the desired station and the receiver, thus permitting th foreign station to be heard.

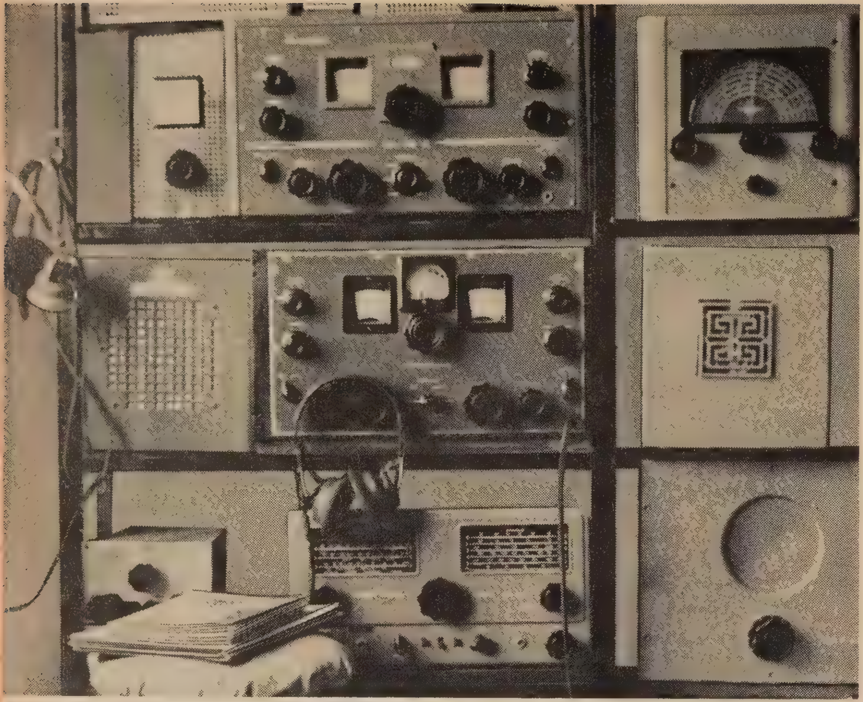
With a moderately priced receive

TABLE II

Frequency (kc)	Station	Location	Power (kw)	Schedule*
674	RTF	Marseilles, France	150	Midnight–6 pm
684	RNE	Madrid, Spain	100	8:30 am–6 pm
701	RTM	Sebaa Aioun, Morocco	140	
773	——	Stockholm, Sweden	150	11:55 pm–6:00 pm
809	BBC	Westerglen, G.B.	100	1:40 am–6:45 pm
818	——	Radio Andorra	140	12:45 am–6:30 pm
881	BBC	Washford, G.B.	100	1:40 am–6:45 pm
908	BBC	London, G.B.	140	1:40 am–6:45 pm
926	——	Brussels, Belgium	150	12:30 am–6:00 pm
1007	——	Hilversum, Holland	120	1:00 am–6:00 pm
1052	BBC	Start Point, G.B.	120	1:40 am–6:45 pm
1088	BBC	Droitwich, G.B.	150	1:40 am–6:45 pm
1286	——	Prague, Czech.	100	10:30 pm–5:50 pm
1439	——	Luxemburg	350	11:45 pm–9:00 pm

*Schedule lists earliest sign-on and latest sign-off times. Some stations operate intermittently during their broadcast day but programs will be continuous during the hours that they can be heard here.

Stations that can be heard on moderate-priced equipment by dxers with good equipmen and a fair amount of skill and experience.



Author's Zahner's listening post at home. You can hear some surprising things with much less equipment—even a car radio.

and good antenna system, either long-wire type or loop, it is not hard to hear the stronger stations from Europe and quite possibly North Africa. It may be more difficult to sit down, turn on the radio and tune to 845 kc for a loud signal from Rome. Most successful dxers report that they sit and wait for the station to break through. Signals are, at best, irregular and are not consistent. In a period of an hour, they may appear for a total of 10 minutes. When there are good "openings" (as the transmission path is called), it is possible to hear a European station for 20 or more minutes. In the winter of 1962, I logged the BBC outlet on 1151 kc for about 40 minutes with no fade or dropout.

Table I shows stations that can be heard by a dxer with minimum equipment and little experience. Table II shows stations that can be heard by a more advanced or experienced dxer with moderate equipment. Usually East Coast dxers can depend on the west and east European stations and west and north African stations. Reception is usually limited to a narrow belt about 100 miles wide along the Atlantic seaboard as far south as South Carolina, though some dx is heard throughout the country.

When to listen

The best time to tune for the foreign stations is at local sunset along the Atlantic Coast and after midnight Eastern Standard Time. (When it is midnight in the East Coast cities, it is 5 or am, almost daybreak, in Europe.) Consequently, early morning reception on the East Coast is limited to 2 or 3 hours after midnight. This time is favorable since many American stations have gone off the air. Particularly clear are Monday mornings because many American stations close at midnight Sunday for equipment checks and tests. This is the time to try for a foreign station near a United States frequency, the BBC on 1151 and 1214 kc or France on 1160, to name three.

Some European signals can be heard at sunset local time and many have been received with surprising strength. Here, again, the signals are traveling through a path of darkness. However, the American stations have not yet closed. Those few "daytimers" who do sign off at sunset do not necessarily make a channel clear, as other stations are there to take over.

The beginning dxer should not attempt to pull in exotic or rare dx unless and until he is equipped to do so, equipped with knowledge as well as with receivers, antennas and the like. Several key stations will tell you almost immediately what to expect. Search first for the Portuguese station on 782. It is slightly higher than WBBM, Chicago, 780. The Portugal station is usually detected as a 2000-cycle heterodyne.

For receivers which have crystal selectivity or "T-notch" filters, the phasing control can take out the offending station and permit the desired carrier to be heard. (Installing a mechanical filter is the easiest way to improve your set's selectivity. See "Add a Super-Selective Mechanical Filter" in the September 1964 issue.) Another key station is Monte Carlo on 1466 kc, which operates from 12:30 am to 8 pm EST.

The best months are December, January and February—each of them will produce trans-Atlantic signals. Ordinarily November, March and April will be the second best, but May and June may produce good results from the higher-powered regular stations.

Language is no barrier although most of the Europeans broadcast in the language native of the country. French, Portuguese and Italian will be the major languages of the majority of European stations. Spanish, Flemish and German can be identified much the same as a dxer identifies them on short wave.

Several commercial logs such as *World Radio TV Handbook* (Gilfer Associates, P.O. Box 239, Park Ridge, N.J.) list the European medium-wave stations, and there are publications which give their schedules. At midnight European time (6 or 7 pm EST), most of the stations close. Rome on 845 kc is a 24-hour station. Monte Carlo on 1466 and the BBC on 1214 kc sign off at 8 and 9 pm, respectively. They open as do their American counterparts—at local sunrise. They provide similar entertainment, but usually carry no commercials. Some identify by chimes, as does Cairo on 818 kc; others by brief anthems, as does Senegal on 764 at signoff.

Giving and getting reports

The hobby of collecting verification cards has grown with radio. A report must contain details which will enable the station to ascertain that it really was being heard. Most European stations maintain an English-speaking member on the staff so that it is not neccessary to report in the language of the country being reported. Include time and date and program details which will let the station know they were being heard, enclose return postage in the form of International Reply Coupons and request a reply. There is the chance of an answer which will serve as your verification. Perhaps it may be a single paragraph from Bordeaux, France (1205 kc) in French—a view card of Mecca from Saudi Arabi (723 kc)—a set of photographs from Belgium (for a report on 926 kc)—or a long letter from the engineer at the BBC.

The foreign broadcaster on the medium waves may not know that his signals are being heard 5,000 miles away. Indeed, the medium-wave staff of Prague Radio was surprised that I was able to hear their outlet on 1286 kc. The BBC engineer made special comment in a verification letter when advised that his station was heard on 1052 kc "considering that New York operates on practically the same frequency." END

INVENTORS OF RADIO

Julius Edgar Lilienfeld, inventor of the solid-state amplifier

By FRED SHUNAMAN

IN THE EARLY DAYS OF THE CENTURY, in Leipzig, Germany, Julius Edgar Lilienfeld attacked the problem of determining why hydrogen could not be liquefied. As one result of his research, Lilienfeld produced the first liquid hydrogen.

Thus began the career of the man who appears to have developed the first semiconductor devices for amplification. Working in the United States on electrolytic capacitors, Dr. Lilienfeld apparently learned much of the nature of conducting and semiconducting compounds, resulting in three patents covering solid-state electric amplifiers. His first patent (No. 1,745,175) describes a "Method and apparatus for controlling electric current." This device consisted of a substrate of glass or other material on top of which two conducting members, "gold, silver, or copper," called 11 and 12 in Fig. 1, a copy of his patent, were placed so that their edges would be very close together. Between the two edges, another electrode of metal foil (13) is juxtaposed in such a way that its upper edge lies flush with the upper surface of the glass. Over the conducting members and the glass between them a film of "copper and sulfur" (presumably cuprous sulfide) is deposited, either chemically or by sputtering or evaporation.

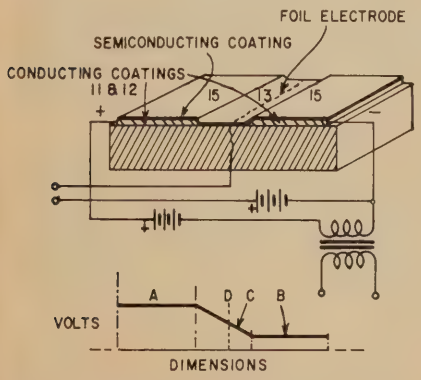


Fig. 1. Lilienfeld's first solid-state patent. Fig. 2. Representation of energy levels in the drawing of Fig. 1.

The theory of the device, as given by the inventor, is that, if one of the connecting plates is held at a higher and the other at a lower voltage, there will be a voltage gradient across the semiconducting layer. As indicated in Fig. 2, *a* may be considered the voltage of Plate 11, *b* that of Plate 12, and *c* the drop across semiconducting layer 15. Varying the voltage on *b* (13 in Fig. 1) varies the impedance to the flow of electrons from 11 to 12, making it possible for the smaller amount of power in the circuit connected to element 13, which would nowadays be called the "base", to control the larger amount of power in the circuit connected to 11 and 12. The patent shows a radio set, with two of these devices hooked up as rf amplifiers, and two as af amplifiers, with a speaker output. We have found no evidence that such a set was ever constructed, and some doubt has been expressed as to whether the amplifier would work at radio frequency.

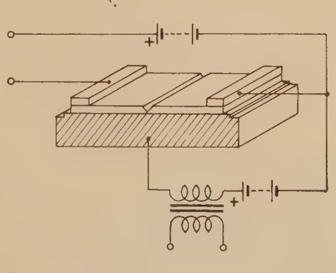


Fig. 3. A later modification of the device "for controlling electric current."

Another patent, No. 1,877,140, Sept. 13, 1932, is called "Amplifier for electric currents," and a third one, No. 1,900,008, Mar. 7, 1933, appears to be a refinement of the original one with the two conducting plates. A single plate of what is described in the patent as copper sulfide rests on a layer of aluminum oxide, which forms the surface of an aluminum substrate. A transverse notch, which, according to the patent, has to reduce the thickness of the top layer to a degree "approaching molecular thickness" is provided, and the "base" contact is simply made to the aluminum block (Fig. 3).

There is some doubt about just how these devices should be classified: as a kind of transistor, or some other type of solid-state amplifier? There is no doubt, however, that Dr. Lilienfeld did invent the first solid-state amplifier of record.

His wife, writing from the Virgin Islands, where Lilienfeld made his home after becoming a citizen of the United States in 1935, states: "His laboratory in Leipzig was a mecca for all interested in high-vacuum, low-temperature work. His X-ray tubes were the first anywhere to be used by the medical profession, and were manufactured in quantity by Koch & Stossel in Dresden." [1]

Before leaving Germany (apparently in the early 20's), he also made important discoveries in field emission. These were actual steps on the road toward the field electron microscope.[2] One worker in that area[3] believes the discoveries reflected a Lilienfeld influence on most field-emission work up to the present. END

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[1] *Science Fortnightly*, P. Lorillard Research Laboratories, April 29, 1964

[2] Müller, Dr. Erwin W., "Practical Field Electron Microscope," RADIO-ELECTRONICS, September 1951, page 43

[3] J. B. Johnson, "More on the Solid-State Amplifier and Dr. Lilienfeld," *Physics Today*, May 1964

CORRECTION

Micro Precision Corp. has informed us that the output of their transistorized muscle exerciser, described on page 43 of the November issue, is 50 volts instead of 15.

SHOP
JACK SCHMIDT

No, it's not a printed circuit, I backed over it in the garage.

Phase, Feedback and Instability

It's how you measure it that counts

By NORMAN CROWHURST

AN AMPLIFIER DESIGN ENGINEER PHONED me, "I've made checks on the phase response of our model XY-00 amplifier, and it shows less than 30° phase shift at either low or high frequencies; but I receive complaints that under certain conditions the amplifier is unstable. Is that possible?" Well, if he gets complaints, it *must* be possible. Investigation showed he was laboring under one of the common misunderstandings about the significance of phase measurements. Incidentally he had also square-wave-tested the same amplifier, with excellent results, but got complaints about the way it handled transients.

The well known stability criteria for an amplifier with negative feedback (are there any others, these days?) states that the gain of the amplifier must fall below 1 before the phase shift gets round to 180° at either low- or high-frequency limits. It is based on the original work of Nyquist and Bode, but an essential feature of this information often gets lost somewhere along the way. What usually is left out is just how gain and phase shift are measured.

Our engineer friend was measuring it from input to output of the amplifier, complete with its feedback loop closed (as you would buy it, in fact) (Fig. 1-a). Unfortunately, the important criteria concern the response from the input of the amplifier **without feedback,** through to the output and back through the feedback loops *ready for connecting to the input again* (Fig. 1-b). This is a very different thing.

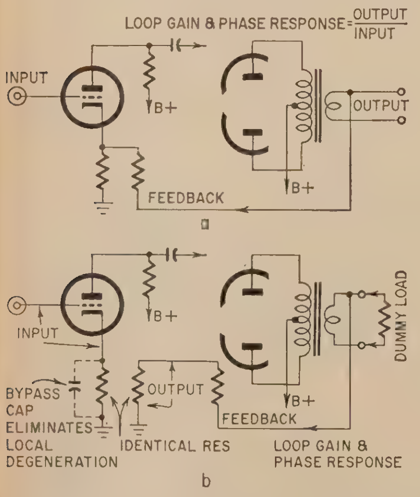

LOOP GAIN & PHASE RESPONSE = OUTPUT / INPUT
INPUT
B+
OUTPUT
B+
FEEDBACK
a
INPUT
B+
DUMMY LOAD
BYPASS CAP ELIMINATES LOCAL DEGENERATION
OUTPUT
B+
FEEDBACK
IDENTICAL RES
LOOP GAIN & PHASE RESPONSE
b

Fig. 1—Difference between (a) normal method of measuring response, gain and phase, of an amplifier, and (b) its loop gain and phase characteristic.

Before we dive in to make measurements, let's take a closer look at the circuit to see what we should expect. It can be made simpler to understand by using the kind of vector diagram that builds into the curve first introduced by Nyquist (Fig. 2). Basically the Nyquist curve is plotted by using points (such as P) that represent the amplifier's loop gain, measured as just described. This is represented by the product $A\beta$, or the length OP, in which quantity A is the amplifier's forward gain (from input to output), and β is a fraction corresponding to the amount fed back. I or OI is the input signal.

This can be measured, even with the feedback closed (provided the amplifier is stable that way and does not oscillate) by measuring the input between grid and *cathode* (not ground) and the output between cathode and ground (Fig 3). If the feedback is through a simple resistor (without any fancy "phase-compensating" capacitors), the cathode-to-ground voltage will be a scaled-down version of the output, but the input is still different from the normal amplifier input.

This loop gain can be plotted either as two separate responses, one for magnitude and one for phase, or the information can be combined in a single Nyquist diagram, if desired, noting the frequencies along the curve (Fig. 4-a). In the Nyquist presentation, the magnitude *and phase* of the loop gain are given by OP and ϕ, respectively (Fig. 2). For any particular frequency, the Nyquist diagram, with a little construction, will tell us about other phase and magnitude relationships.

The important thing about the diagram (known as the *Nyquist criterion)* is whether the curve stays "inside" point I, as at Fig. 4-a. Here, although the feedback gets to be positive instead of negative just above 40 kc, it is not enough to equal the input (OI), and hence the amplifier is stable. If the curve goes around point I, as in Fig. 4-b, the positive feedback at just over 40 kc is more than the original input and the amplifier will oscillate. But let's see what else we can learn from this diagram.

The original input (between grid and cathode) is represented by the unit length OI (Fig 2). The fed-back signal is out of phase, ideally, with OI, and starts at OM. But amplifier phase shift,

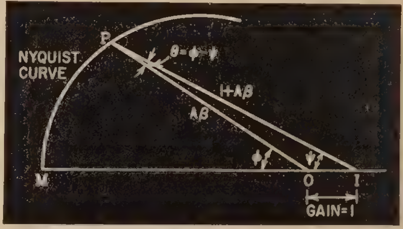


Fig. 2—Basic construction of polar diagram for one frequency that leads to the Nyquist curve.

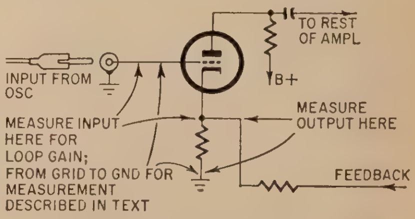

TO REST OF AMPL
INPUT FROM OSC
B+
MEASURE INPUT HERE FOR LOOP GAIN; FROM GRID TO GND FOR MEASUREMENT DESCRIBED IN TEXT
MEASURE OUTPUT HERE
FEEDBACK

Fig. 3—Measuring an amplifier's loop-gain response with feedback loop closed.

ϕ, brings it to the value represented by OP. So the actual input needed for the amplifier with its feedback loop closed will be the remaining side of the triangle, IP. Thus the difference between the amplifier input as seen from the outside and as the amplifier sees it, because of its feedback, is represented by IP and ψ in magnitude and phase. Using I as the center or reference point instead of O, the same Nyquist curve can be used to show the actual input needed to get an effective input OI.

Now, if we connect our gain and magnitude measuring equipment so the input is measured in the usual way, grid to ground, while the output is measured from cathode to ground (also shown in Fig. 3), the input quantity is represented by vector IP, while the output quantity is represented by OP. The magnitude of this "gain" will be the ratio between IP and OP, while the phase angle measured will be the difference between ϕ and ψ, or θ.

If the feedback is just a resistance, then the amplifier output will be a "scaled-up" version of OP, before it is cut down by fraction β, and the angle θ will be the phase between input and output of the whole amplifier, complete with feedback. Notice that, while the angles ϕ and ψ get relatively large, the angle θ remains quite small. This is the angle our engineer friend assured us stayed within 30°.

Gain is a little difficult to visualize as the ratio between the lengths of two lines, but there is a fairly simple way to make it easier. If we find all the points for P, such that IP is twice OP, which would mean the loop gain with feedback included is −6 db, they will lie on a circle (Fig. 5). Similarly, all the possible points for any other specific ratio of IP to OP will make another circle.

It is relatively easy to draw a whole family of circles, each representing a specific value of possible *overall* gain (as measured on the complete amplifier rather than loop gain). In this way, the same Nyquist curve can now be used to read off overall gain, with feedback closed, except that the output used is after it is fed back to the input, while the actual output is obtained before the feedback cuts it down by β. But if this is a simple resistance, the *relative* gain is accurately given in this way.

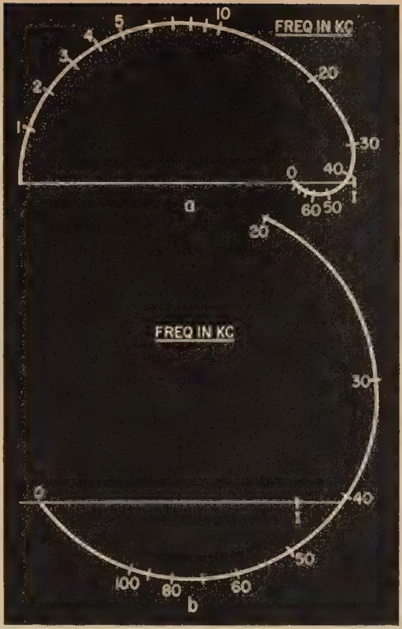


Fig. 4—Nyquist curves with frequency marked: a—stable; b—unstable.

Now we can visualize, with this diagram, how feedback works to produce peaking in the loop-gain response (with the loop closed) as well as merely to find out whether the amplifier is stable or not, by whether the curve goes outside or inside the point I. Fig. 6 represents a magnified section of a Nyquist curve plotted against the circle background in the region that determines the rolloff characteristic.

If the curve pushes outward over the pattern of circles, this represents a rising response, toward a peak, while if the curve goes inward through the circle pattern, toward its ultimate destination at O, there is no peak, just a smooth rolloff.

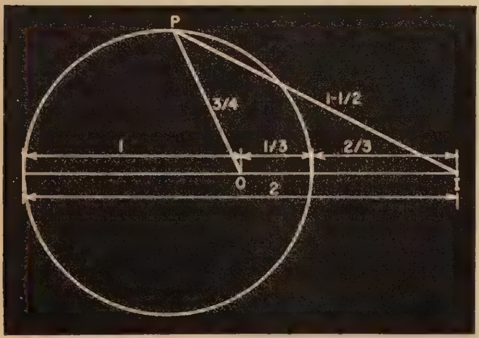
With this method as an aid, we can further investigate what to expect from a practical amplifier. If the amplifier has been well designed, so one internal rolloff acts well before all the others, the Nyquist curve will start out as a slight departure from a semicircle, finishing up with a tiny spiral (Fig. 7-a).

Each stage, or coupling, in an amplifier causes at least a high-frequency rolloff, or turnover, due to circuit self-capacitance beginning to bypass the circuit's basic impedance. Stages where a coupling capacitor is used will also cause a low-frequency rolloff or turnover, which occurs where the reactance of the coupling capacitor becomes equal to its associated circuit impedance. The performance of the amplifier, as shown in its Nyquist curve, is determined by how these turnovers combine, as fixed by choice of circuit values.

For example, one low-frequency rolloff may be at 20 cycles while the remainder are all below 2 cycles. Similarly, one high-frequency rolloff may be at 20,000 cycles while the others are above 200,000 cycles. If this arrangement uses enough feedback to produce a peak, the point where it reaches the peak, represented by the farthest "out" in the pattern of circles, will be where the angle θ between OP and IP is in the region of 90°, while the angle ϕ will be between 135° and 180°. This is the point where the amplifier comes nearest to being unstable and where transients may cause ringing.

Notice that it is different from either the gain margin or the phase margin (Fig. 7-b), as normally defined. It falls at a frequency between them. Gain margin is the amount ("spare") between the point where the curve becomes purely positive feedback, represented by crossing OI, and point I, where it would just oscillate. Phase margin is the angle short of the 180° needed to make the feedback pure positive, when the gain around the loop is just 1, shown by the radius from O being equal to OI. Gain and phase margins are idealized quantities difficult to identify in practical measurements, but this peaking point is easy to locate. It is where amplifier gain is highest.

Sometimes amplifiers are designed, either deliberately or unintentionally, so several rolloffs act more or less together at the same turnover frequency (say, all of them start at 20 and 20,000 cycles). In this case the Nyquist curve will deviate much more from the original semicircle, so as to swing inside point I at quite a different angle (Fig.



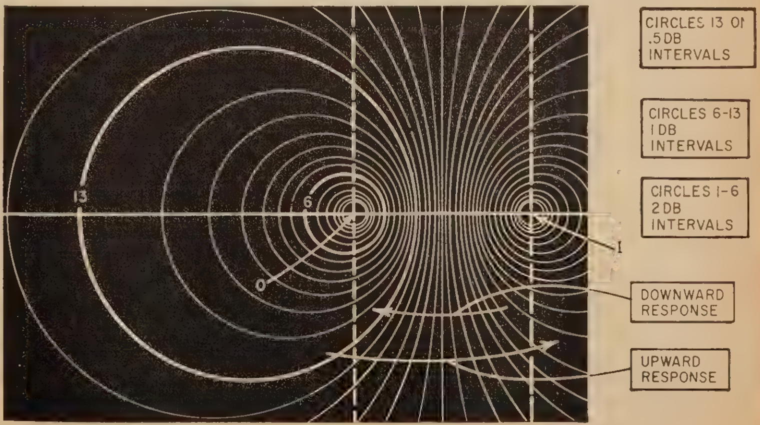


Fig. 5 (left)—Construction for one circle representing constant input-to-output gain (for $A\beta(1 + A\beta) = \frac{1}{2}$). (Right)—A whole family of such curves that can be used for determining overall frequency response from Nyquist curves.

7-c). This kind of design usually means the gain margin is rather small, and likely to take trips into oscillation under certain circumstances. Also the phase angle θ where peak occurs will be much bigger than 90° and getting nearer to 180°, more like the angle φ in this case.

Now we have some information we can use in taking amplifier response characteristics. Instead of looking for the 180° point we need to pursue the response out to a peak, if there is one. If the phase angle at this peak is in the region of 90°, the amplifier is inherently stable, but it has a peak that may spoil its transient performance. But if the peak occurs nearer to 180°, even though the peak is not a very high one, the amplifier could be unstable in places.

So far we have assumed that the feedback does not use any "phase-compensating" capacitors—at least not in the feedback circuit. If it does, then we cannot use the output voltage compared directly with the input voltage. What we need to compare is the fed-back voltage with the input voltage (Fig. 3). This is what we shall do in the next article of this series. END

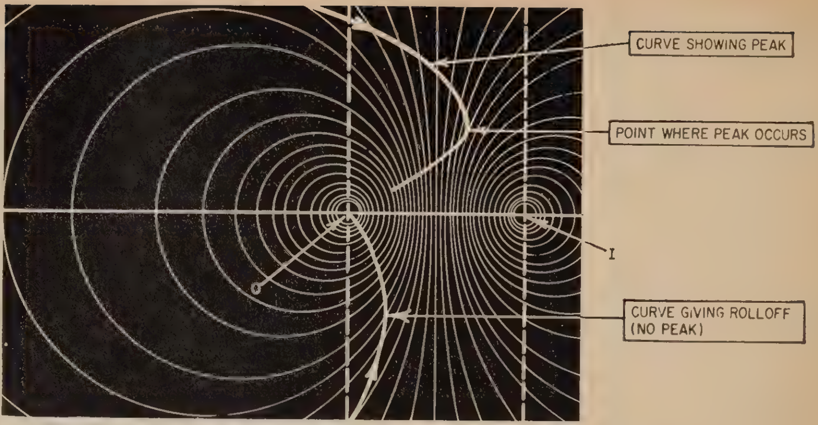


Fig. 6—How direction in which Nyquist curve crosses pattern of circles indicates nature of response curve and condition at peak, where one occurs.

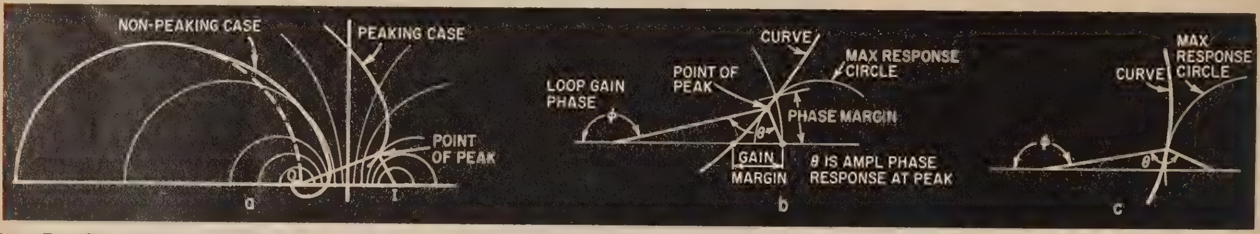
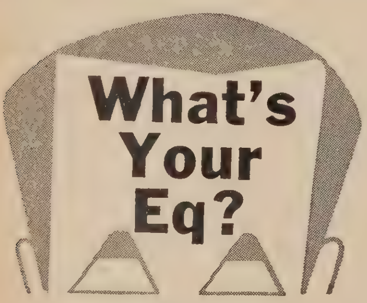


Fig. 7—Criteria involving phase, relating to an amplifier that peaks: a—a good shaping that avoids stability troubles: b—same part magnified to show difference between peaking point found in phase analysis and the usual criteria of gain and phase margins: c—a curve that represents an amplifier more likely to give marginal trouble.



What's Your Eq?

Conducted by
E. D. CLARK

Three puzzlers for the students, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especially interested in service stinkers or engineering stumpers on actual electronic equipment. We get so many letters we can't answer individual ones, but we'll print the more interesting solutions—ones the original authors never thought of.

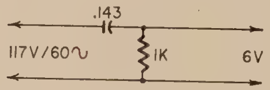
Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York, N. Y. 10011.

Answers to this month's puzzle are on page 89.

Noise!

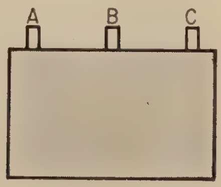
We needed a clean, 6-volt 60-cycle test signal in an industrial electronic circuit. The old dodge of using the reactive drop of a capacitor to reduce the 117-volt line voltage to 6 was tried. This method uses a capacitor instead of the heat-producing resistors or expensive transformer normally used. The resistor and capacitor form a voltage divider, the reactance providing the required drop.

This technique was tried a slightly noisy power line. The 117-volt waveform looked good on the scope, but the output waveform was terrible! Why?—*Donald E. Lancaster*



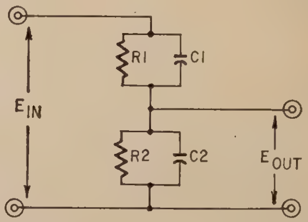
Another Black Box

Voltmeter tests read zero between any two terminals, so ohmmeter (vtvm type) is connected to measure resistance. Between A and C, infinite resistance is indicated. Between A—B or C—B, the meter indicates 14 ohms on R x 1 range, 140 ohms on R x 10 range, 14K ohms on R x 1K range, and 135K ohms on R x 10K range. On the highest range (R x 1 meg), the indicated resistance is 6 megohms. What do we have here that seems to change resistance? No semiconductors are involved.—*Mivko Voznjak*



Input and Output

The attenuator in the diagram is designed so that the ratio of the output voltage to input voltage is *independent* of the frequency of the input. What restriction does this place on the values of the components?—*J. A. Chambers*

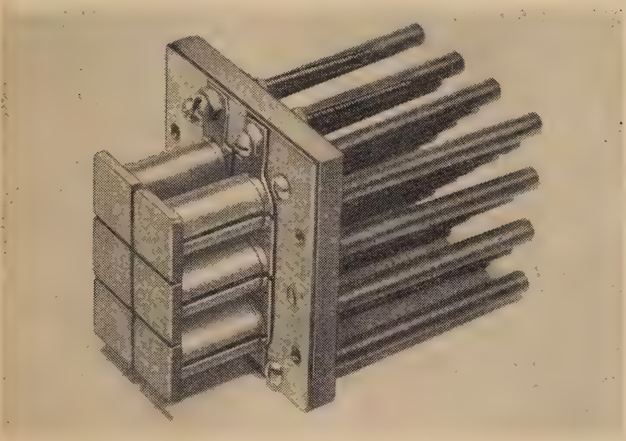


50 Years Ago

In Gernsback Publications
In December, 1914,
Electrical Experimenter

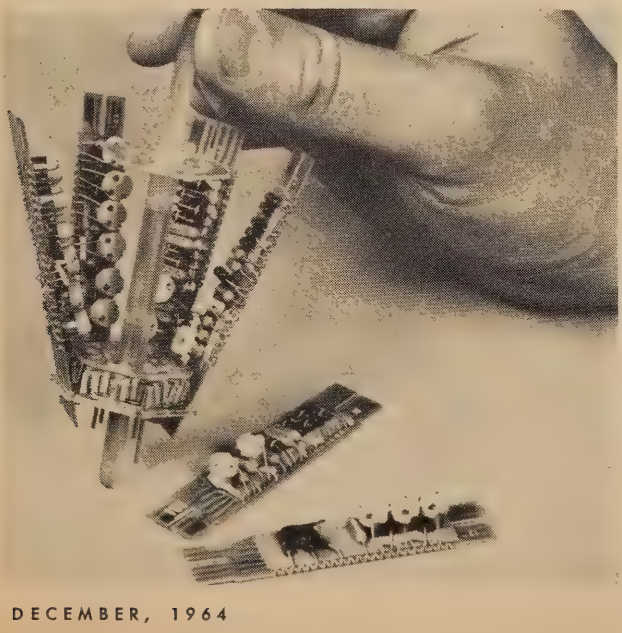
Miniature High Frequency Outfit, by H. Winfield Secor.
Pocket Wireless Set, by Leo E. Gleim.
Radio Laboratory at Columbia University.
40-Kilowatt Electromagnet.
The Wireless Direction Finder.

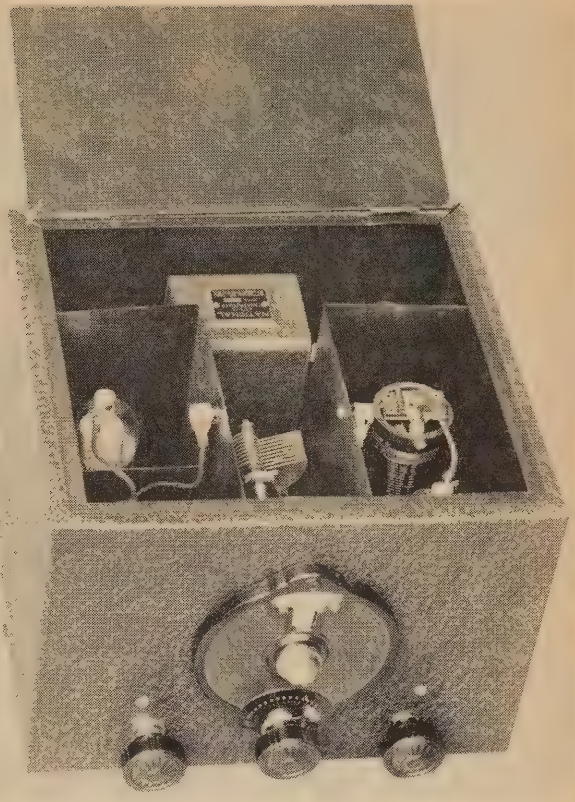
WHAT'S NEW



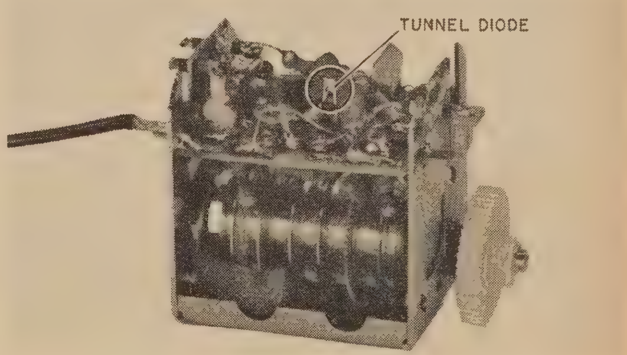
100-WATT "FOSSIL FUEL" GENERATOR comes in "building-block" modules for flexibility in output voltages. Developed by RCA for the US Army, the silicon-germanium thermoelectric units generate electrical energy from the heat of burning such fuels as leaded gasoline. Cool junctions are free-convection-cooled. Voltages to 30 and powers to 500 watts are obtainable by combining modules.

ELECTRONIC SHISH KEBAB makes indigestible dinner but highly compact computers. Developed by the Burndy Corp. and called a "hexagonal modular electronic packaging system," the honeycomb configuration won a first prize in the Advancement of Packaging/Production Techniques competition held at this year's National Electronic Packaging & Production Conference (NEP/CON '64). The module offers a high ratio of plane surface to volume, on six discrete printed-circuit boards, in a pluggable, easily assembled, highly accessible unit.

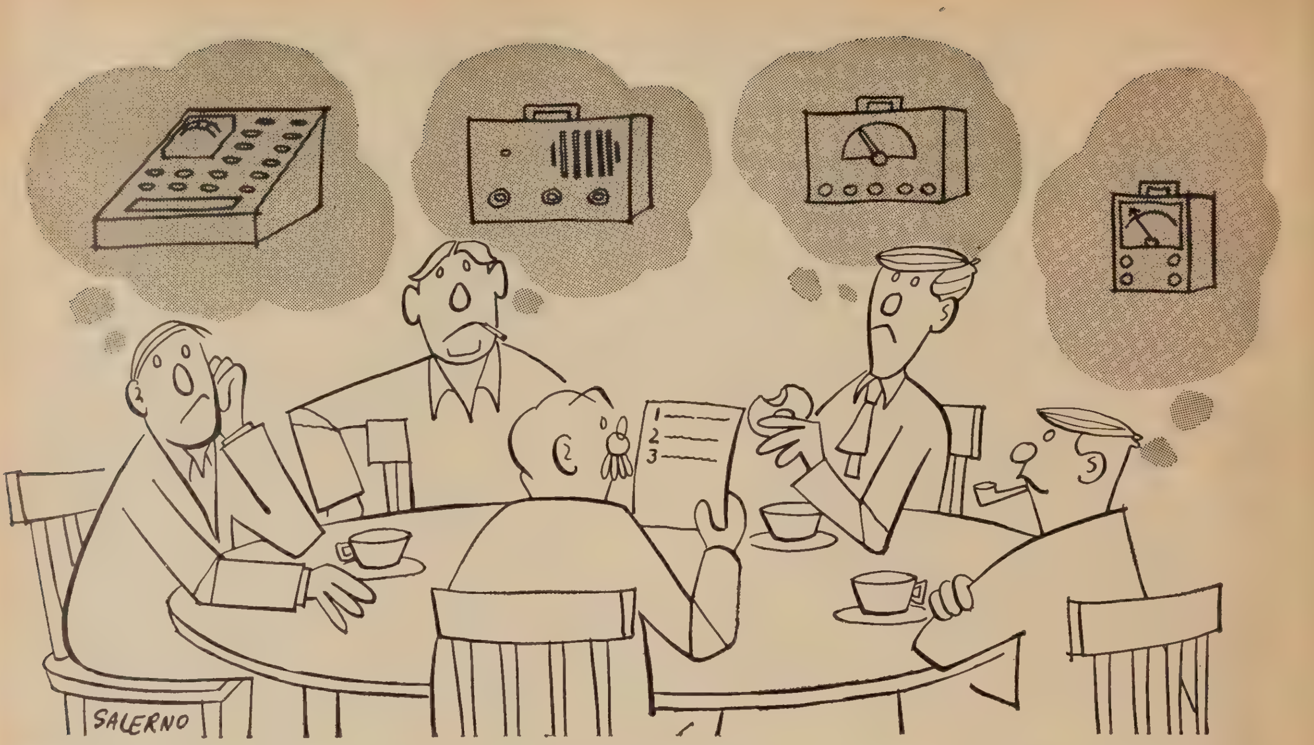




WHAT'S OLD? ONE OF THE ALL-TIME CHAMPIONS—the SW-3, advertised in 1931 as "bristling with original and ingenious features." Nostalgic photograph was issued by National Radio Co. in this, its 50th anniversary year. Complete with "Velvet Vernier" dial, the SW-3 would, in the hands of the expert old-timer, pick up on headphones anything he expects to get with a selective 12-tube receiver in these congested days. Why? Well, approaching "the point of maximum sensitivity . . . along inverse exponential curve, giving stable operation without critical setting of control" may have had something to do with it.



TUNNEL DIODE serves as FM local oscillator in Sony EFM-117 portable radio. FM circuit uses two transistors besides—one as rf amplifier and one as mixer. Though we call it a tunnel diode, the Sony service manual consistently calls it an Esaki diode, after the Japanese discoverer. Another interesting feature is the use of inductive tuning (the discs are inductors).



What do You Need for a Good Shop?

The Service Association designs a perfect layout of shop equipment — with one omission!

By JACK DARR
SERVICE EDITOR

"THERE'S NO SUCH THING AS AN IDEAL service shop", said Fred firmly.

"Oh, I dunno," demurred the Old-Timer. The service meeting was over, the lecturer gone and, as usual, the Old-Timer and some of his friends were waving half-cups of coffee at each other in their regular after-meeting bull session. The Young Ham, also as usual, was quietly demolishing the rest of the fresh doughnuts.

"Well, what would you call an ideal setup?" asked Bob.

"Don't know, right now." The Old-Timer grinned. "My wife says I git every new gadget I lay eyes on, whether she can afford it or not!"

"I'll believe her," snorted Pete. "I've seen that shop of yours."

"Just for fun, let's find out," protested the Old-Timer. "We got a pretty good group of representative citizens right here now. Let's see just what they think a feller ought to have, to be able to test every kind of part he runs into in radio an' TV work. In other words, a 'full set' of test equipment. Let's make up a list." He picked up a discarded program from the table. "All right, somebody start."

Everyone spoke at once, as usual. The Old-Timer waved his hands in the air. "Hey! Whoa! We're gonna need some ground rules or we'll be here all night! How about this? Let's limit this to a straight radio–TV–sound service shop. No two-way radio or anything that needs special kinds of test equipment. OK?" They all agreed. The Old-Timer wrote "1" on the top of the sheet, and said, "Well, somebody start!"

"Tube tester," contributed Pete. "Good," said the Old-Timer, writing it down. "Next?"

"Picture-tube tester," said Fred. "OK", and it went in as No. 2.

"Voltmeter," said Bob.

"Good. Now, wait a minute. This is a combination instrument—a vtvm or vom, that'll measure volts, ohms, current, etc? So, this one instrument will take care of our voltage, resistance and current measurements. Right?" All agreed, and this became No. 3. Someone suggested, "High-voltage probe for that?" and it was added.

"Capacitor tester?" asked the Old-Timer. Everyone nodded, and this was No. 4.

"Flyback tester?" Pete spoke up again. "Horizontal-sweep circuit tester?" said Fred.

"Whoa!" yelled the Old-Timer. "Now, Pete, you mean the resonant-circuit tester that finds shorted turns, and Fred, you mean the one that can substitute plate or grid drive in a set, and also check yokes, and so on?" Both nodded in agreement. "Looks like those oughta go in the same category, and then a feller could take the one he likes best." So these were lumped together as No. 5. "Next."

Several voices spoke at once, punctuated by the Old-Timer's "Hey, one at a time!"

"I said 'color bar generator,'" said Bob, and several others nodded. "Good," said the Old-Timer. "I'm with you. Gittin' to be an essential instrument. Anyone disagree?" No one did, so in it went as No. 6. As he wrote, someone spoke up from the back of the group. "How about a pattern generator?" This started a small argument. "Pattern generator's too big to take on house calls!" "Yeah, but it's sure handy in the shop! Wouldn't be without one!" "You can set up color sets with the crosshatch and dot slides, and mine's got a color bar in it!" and so on and on. The Old-Timer raised his voice. "Simmer down! How about lumpin' those two under the same heading and let each guy take the one he wants? They do have a lot of the same functions." This satisfied everyone.

"Next?" Quiet. Everyone was thinking. "Signal generator?" suggested the Old-Timer, and started another argument. Some liked straight signal generators, others liked sweep generators, and still others wanted a combination of the two. In the end, they compromised again, and listed "Signal and sweep generators" as No. 7.

THE OLD-TIMER'S LIST.

1. Tube tester
2. Picture-tube tester
3. "Voltmeter" (vtvm or vom, with high-voltage probe)
4. Capacitor tester
5. Horizontal sweep circuit testers (flyback tester, or horizontal sweep "substitute" tester)
6. Color bar generator (bar-dot-crosshatch-color bar generator, or pattern generator, with dot-crosshatch slides, or provision for making color bars)
7. Signal and sweep generators
   FM-stereo signal generator (optional)*
8. Audio signal tracer, with detector
9. Transistor checker (optional)*
10. ____________

What did we leave out?

"Hey, how about those new FM stereo signal generators?" Fred wanted to know, and started another argument. Some thought they would be absolutely necessary, others didn't know, and still others objected to the high cost. Finally, the Old-Timer asked, "Hey! Remember that article by Leonard Feldman in the June RADIO-ELECTRONICS? Servicing FM stereo with a station signal instead of a high-priced generator? That ought to get us off the hook for a while. If you wanted to, you could do that until you could buy one of the special generators. Meanwhile, let's put it down as an optional, huh?" This was done, and they went on.

"Signal tracer?" said someone.

"You mean the little thing with the amplifier, speaker and so on, and a crystal detector for rf? Used for servicing radios?" "Yep, that's it. Handy little gadget, too." For once, everyone agreed, and this was set down as No. 8.

"Transistor checker!" said Bob, and then the argument began in real earnest! Half claimed that transistors seldom went bad, the rest swore that "they do too!" Some liked substitution, others wanted to test each one, like tubes, and a few liked ohmmeter testing. This was really going hot and heavy when the Old-Timer broke it up with a roar. "HEY! It's gittin' late! Let's put *that* one down in the 'individual-preference' category and forgit about it!" So they did.

"How about a Q-meter?", "Wheatstone bridge!" and "Inductance bridge!" came from several sides. The Old-Timer studied for a moment. "Tell you what," he said thoughtfully. "I'll admit this is just *my* idea, and might not be right, but I always looked at that as *design* equipment rather than strictly *servicing* equipment. Fine, and, if we had a use for it, it'd be wonderful, but what do we actually *do?* We look for bad parts in radios and TV sets. When we find one, we look it up in the parts list, then go down to the store and git an exact duplicate. We don't build 'em—wind our own coils and stuff like that! So, it looks to me as if this type of instrument wouldn't fit in with what we're tryin' to get—*servicing* equipment. What do you guys think?" There was a moment of quiet, then each head nodded in agreement.

The Old-Timer checked the list. "Come on, you guys. There's bound to be more'n this." Everyone put on a thoughtful look. The Old-Timer looked up, and saw the Young Ham still stuffing doughnuts into his face. "Junior!" he roared. "Git away from there! Dadblame it, you're gonna be sick! That's about 17 dougnuts so far! Git!" The Young Ham retired to a chair, only to tiptoe back as soon as the older man's back turned.

"Well, here's what we got now," said the Old-Timer, displaying the list. "The ones we're all agreed on first, the one's where there was a difference of opinion marked with an asterisk. What d'ya think of 'em. Does it look as if a feller could test about any part of a radio or TV set with a setup like that?" There was a general nodding of heads. The Old-Timer got a sneaky grin on his face, and asked, "Don't think of anything we left out?" All of the heads shook "No", although some looked very doubtful. "Sure now? We mighta missed one, y'know." More head-shaking.

With a bigger grin this time, the Old-Timer said, "Well, I didn't think of it till just now, but there's one *fairly* useful instrument that all of us have already, and use a lot every day, an' we missed it, every dang one of us. What is it?"

They all looked puzzled and sheepish—that look you get when there's something you *ought* to remember but can't. The Old-Timer beckoned them closer, and whispered one word into their ears. They all shouted with laughter, grabbed the Young Ham under the arms and carried him out the door, dribbling doughnut crumbs as he went.

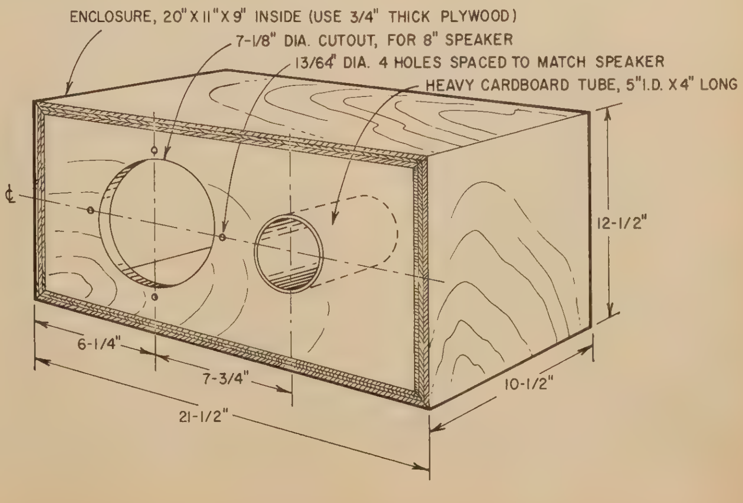
What was the one important instrument they had all overlooked? END

(The *oscilloscope*, of course!)

Inexpensive Speakers Improve Transistor Sets

MANY AUDIO FANS CAN IMPROVE THE sound of their transistor radios, tape recorders and portable record players by feeding the audio into an external speaker in an adequate enclosure. The diagram (from *Audio Times*) shows a simple bookshelf type enclosure for inexpensive 8-inch speakers such as the Electro-Voice MC-8, Wigo ER-5 and similar models made by Norelco and others.

The sides, top and bottom are ¾-inch hardwood veneer plywood. The front panel and back are commercial-grade fir plywood. A strip of ¾ x ¾-inch stock is used for glue blocks and cleats. The front panel is covered with grille cloth. The inside is lined with 1-inch-thick glass-fiber insulation. You can use butt joints in construction and cover the exposed edges with a veneer tape.



ENCLOSURE, 20" X 11" X 9" INSIDE (USE 3/4" THICK PLYWOOD)
7-1/8" DIA. CUTOUT, FOR 8" SPEAKER
13/64" DIA. 4 HOLES SPACED TO MATCH SPEAKER
HEAVY CARDBOARD TUBE, 5" I.D. X 4" LONG
℄
12-1/2"
6-1/4"
7-3/4"
21-1/2"
10-1/2"

MORE METERS FOR BEGINNERS

Ohmmeters, db scales, current probes

By ROBERT G. MIDDLETON

MOST OF THE METERS USED IN TV servicing have test leads. The resistance of the test leads is important on the R × 1 range of an ohmmeter. Fig. 1 shows the basic principle of ohmmeter action. An internal battery supplies current to a multiplier resistance R. This current flows through the meter movement, through the test leads, and through R_o, resistance to be measured. This diagram, which is reduced to the essentials, makes it obvious that the test leads will introduce an error in measurement if their resistance is abnormally high. Thus, if the leads become frayed internally, for example, R_o will appear to have a falsely high value.

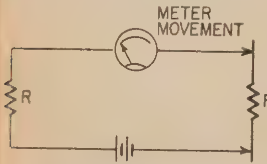


Fig. 1—Basic ohmmeter circuit.

This error might seem unimportant in a practical ohmmeter which includes a zero-adjust control (Fig. 2). The zero-adjust control is useful in setting the pointer to reference zero on the scale, when the battery voltage falls off from its "fresh" value. Hence, you might conclude that the zero-adjust control compensates for test lead resistance. To illustrate the error of such a conclusion, let us take a practical example.

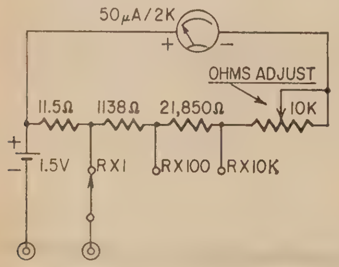


Fig. 2—Complete practical ohmmeter circuit.

A peaking coil has a resistance of 5.5 ohms. The ohmmeter reads correctly when the test leads are in good condition. A frayed lead caused the ohmmeter to indicate that the coil's resistance was 4.6 ohms *even though the ohmmeter was correctly zero-set*. The abnormal lead resistance *subtracts* from the true resistance value.

Battery condition

Fig. 2 will show that the same basic error crops up when the ohmmeter battery approaches the end of its useful life. Fig. 3 shows the reason. A battery has internal resistance. When the battery is fresh, its internal resistance is low. When the battery weakens, its internal resistance increases although its emf (electromotive force) remains practically the same. In other words, a weak battery will *seem* to be good if tested with an ordinary voltmeter. Under load, its voltage measures below normal.

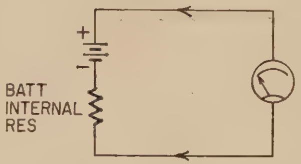


Fig. 3—Batteries have internal resistance.

Such a battery appears "good" on a voltmeter test, and "weak" under load because a substantial portion of its emf is dropped across the abnormally high internal resistance. In an ohmmeter, the battery's internal resistance is added to the test-lead resistance. Hence, a weak battery has the same effect as defective test leads. It is easy to measure the internal resistance of a battery (Fig. 4).

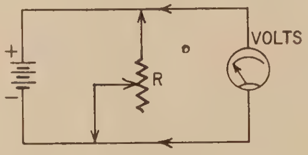


Fig. 4—Measuring a battery's internal resistance.

First, measure the battery voltage on open circuit. Then connect a rheostat (R) across the the battery as in Fig. 4, and set the rheostat to the point where the voltmeter indicates one-half of the open-circuit voltage. The resistance of the rheostat is then equal to the battery's internal resistance. For example, a typical "good" size-D flashlight cell might have 0.4 ohm internal resistance.

This test works as shown in Fig. 5. When load resistor R has a value equal to the internal resistance R_{int}, a voltage divider is set up which applies one-half of the battery's emf to the voltmeter. Note that this is also the basic principle used in ordinary battery testers, which indicate good or bad on the basis of a battery's terminal voltage under normal load.

Testing the test leads

If you suspect that the test leads are frayed internally or that contact resistance is high, it is easy to check. Remove the leads from the ohmmeter and replace them with a short jumper of heavy copper wire. Turn the zero-adjust control to bring the pointer to zero. Then remove the jumper and plug in the test leads. Short the leads together and note the meter reading. A typical value is 0.1 ohm. A substantially higher value, such as 1 ohm or more, confirms your suspicion.

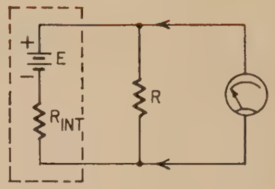


Fig. 5—When the internal and load resistances are equal, voltmeter indicates exactly half of battery's unloaded terminal voltage.

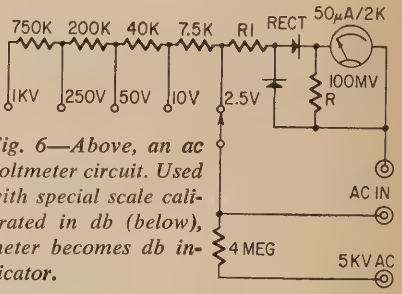
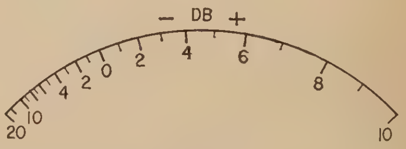


Fig. 6—Above, an ac voltmeter circuit. Used with special scale calibrated in db (below), meter becomes db indicator.



The decibel scales

These are used chiefly in audio test work. Unlike the voltage scales, a decibel scale (Fig. 6) is nonlinear. Its usefulness is based on the fact that the perception of loudness is proportional to logarithmic units like decibels, and not to voltage. Ten decibels equal 1 bel. When the system was established, it was based on the premise that 2 bels represented a sound level twice as loud as 1 bel. As a matter of fact, many persons will judge that an increase from 1 bel to 1.8 bel, for example, doubles the loudness of a sound. This difference in individual judgments, however, does not affect the utility of db measurements now that the db has been established and its meaning fixed.

As illustrated in Fig. 7, the decibel ranges are referred to a standard load, such as 600 ohms. In other words, unless the test leads are applied across a 600-ohm load, the db indication will be incorrect. What is the reason? Simply that the decibel is fundamentally a power ratio, and a vom is not a power meter. Since a vom operates as a voltmeter on its db ranges, it must be applied across a known resistance so that the scale reading will be proportional to power.

This is not to say that db measurements are meaningless when made across other than the standard load value. For example, if both the input and the output of an amplifier have the *same* impedance it is possibie to make db input and output measurements and to subtract the input reading. The difference is the actual gain of the amplifier in db. But note carefully —both the individual measurements are incorrect (in absolute terms), although the *difference* between the readings is a valid, correct value.

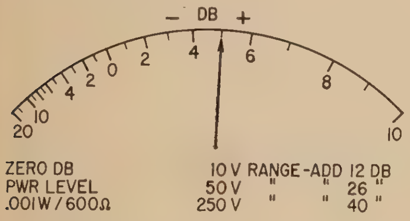


Fig. 7—Pointer shows 5 db on lowest range (2.5 volts full scale). On 10-volt range, add 12 db (according to data in instruction book or on meter scale). Hence pointer, still at 5-db mark, reads 17 db.

It is *not* possible to use this method of measuring gain when amplifier has different input and output impedances. In such a case, rather involved correction factors must be used. They are often impractical in a busy shop.

It is essential to add the specified number of db to the scale reading when you use any range other than the first ac-voltage range, as in Fig. 7. To put it another way, if the vom is switched to its 2.5-volt range, the db scale reads directly. But if the instrument is switched to its 10-volt range, we must add 12 db to the scale reading. Note the positive and negative scale sectors above and below zero db. These won't cause confusion, if you remember simply to observe the *interval* between readings (Fig. 8). In other words, if the first reading is −10 db and the second reading is +10 db, the total interval is 20 db.

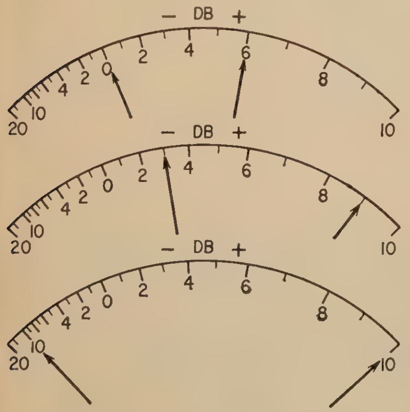


Fig. 8—On top, a 6-db interval. Center, another 6-db interval. Bottom, a 20-db interval.

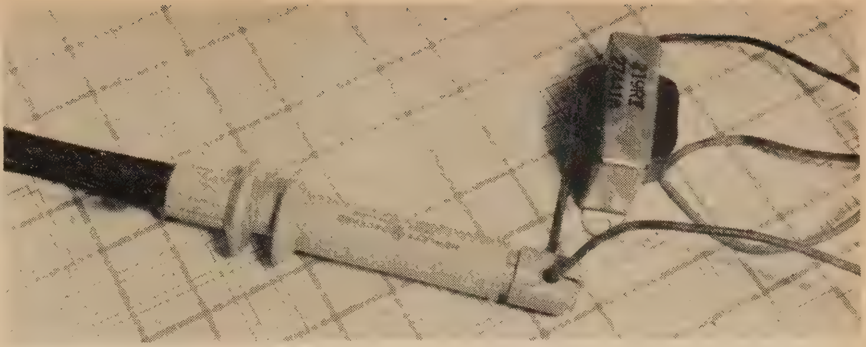


Fig. 9—Hewlett-Packard current probe clamped around insulated transformer lead.

Current probes

Until recently, current (ac) had to be measured in one of two ways. Voltage can be measured across a series resistor in the circuit, and the current calculated from Ohm's law. If there is no series resistor, the circuit must be broken. This of course is time-consuming, and limits the convenience of current tests. In most shops, current is measured only when absolutely necessary.

However, it is now possible to measure current as easily and quickly as voltage. In fact, it is easier to measure current with a current probe (Fig. 9) than to measure voltage, because no connection is made to the circuit. The current probe (made by Hewlett-Packard) is basically a miniature "half-transformer" enclosed in a probe housing. Clamped around a wire, the probe becomes the secondary, and the wire is equivalent to a one-turn primary. Circuit loading is extremely light, because there is only a small magnetic coupling to the wire. The current probe is shielded, so it does not respond to electrostatic fields. Only the magnetic flux surrounding the wire contributes to the probe output.

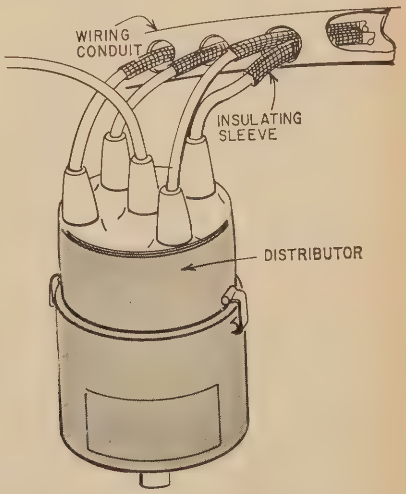
The probe is used with a vtvm. It contains a transistor amplifier and a gain control (only a maintenance adjustment). Thus, the probe can be calibrated to read current values with high accuracy. Such probes are available with uniform response from near dc to 400 cycles. The probe illustrated in Fig. 9 is designed for ac measurements only, and has flat response from 60 cycles to 15 mc.

It is not practical to use a current probe with a vom, because the input resistance of the instrument changes when the range switch is turned. The probe would have to be recalibrated each time the vom range was changed. On the other hand, a vtvm has constant input resistance on all ranges.

The probe indicates current on the voltage scales of the vtvm. A typical probe calibration factor is 1 millivolt per milliampere. Thus, a current flow of 75 ma produces a probe output of 75 mv. If small currents are to be measured, this type of probe is used with an audio vtvm, which has suitable low-voltage ranges. END

KEEP TRANSISTOR SPARK POWER WHERE IT BELONGS

THE EXTRA-HIGH VOLTAGES IN TRANSISTOR ignition systems put unusual electrical stress on ignition cables. But unless the wire is in very bad condition, you won't need to rewire the car. Slip a section of insulating sleeve or polyvinyl tubing (from hobby shops) over the parts of the wire where the stress is greatest—: where the wire enters a conduit or where it is fastened with metal straps to the motor or frame.



You can determine where it will be most needed by reving up the engine in total darkness. Breakdown places will show up with a blue glow or blue sparks. They are the points that need extra insulation.—*Tom Jaski*

The size of a pack of gum, this amazing probe can inject signals or trace them — without switches or controls of any kind! Works from audio through vhf

Tracex—A Transceiver-Type Probe

By EDWARD BURKE, JR.

THE PERFECT TEST INSTRUMENT should be a little black box that generates and detects all frequencies from zero to infinity; has no knobs, switches or adjustments; weighs nothing; consumes no power and costs nothing to own or operate. Sounds like science fiction? It is! But the Tracex probe fills most of those requirements. Here are some facts:

Power input: 1 volt ±0.5 at 100 microamperes.

"Trace" mode: Amplifies or detects all frequencies from 10 cycles to above 500 mc.

"Inject" mode: 750 cycles, harmonics to above 40 mc.

Size: No larger than a man's thumb.

Weight 1½ ounces without accessories.

Switching: Automatic, normally oscilating. Plugging in earphone converts to detector–amplifier for "trace" mode.

Cost: $5—no junkbox material.

Applications?

"Inject" mode: af, i.f., rf through vhf. Identify cable pairs, check video cable continuity at normal video voltage levels and waveforms. Identify telephone channels without impairing service on adjacent channels. Signal-trace all types of radio receivers and audio equipment.

"Trace" mode: af, i.f., rf through 500 mc. Check operation of oscillators by comparing clicks—direct current produces little or no click. On-the-air modulation check. Trace video (buzz) at normal levels. "Read the mail" on *any* type transmitter through body capacitance by touching Tracex tip to nearby metal object. Demodulate carrier telephone at test points for troubleshooting frequencies on any type open-wire or cable carrier.

Accessories?

Several simple gadgets extend the usefulness of Tracex:

A high-impedance magnetic earphone serves as a stethoscope microphone for monitoring machinery vibration by contact. It will pick up low-frequency hum from audio and power transformers. A larger open-core inductor can monitor telephone subsets when placed near the transformer in the base.

Where induction is not required, a crystal earphone makes an excellent contact mike.

A tuned circuit connected to Tip and Clip will provide selective rf "sniffing."

A broad-band rf sniffer can be made from a 2-inch plastic jar top. Wind 50 turns on the top and fasten one end to a banana plug in the center, leaving the other end of the winding free. Plug the cap into the three-way binding post Tip of the Tracex, and the earphone into the monitor jack. Hold the Tracex so that one finger rests on the Clip. If you have a local broadcasting station within 5 miles or so, you can trace your house wiring, water pipes and even gas pipes.

If you have a modulated signal generator, hitch it to the faucet in the backyard and trace the pipes underground. (Don't do this in the front yard —your neighbors will think you are crazy.) The uses for Tracex are limited only by your ingenuity.

The circuit

Fig. 1 is a clamped multivibrator.

Capacitor C1 at the Tip has several functions. The value is optimum for high attenuation of the low audio frequencies and very low attenuation at radio frequencies. C1 has a dc working

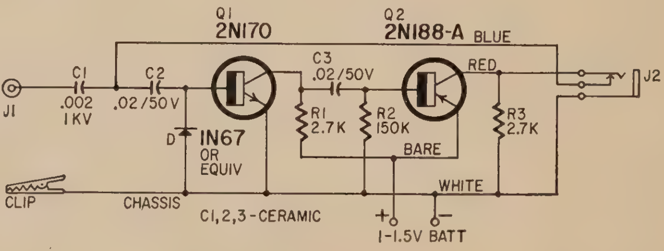
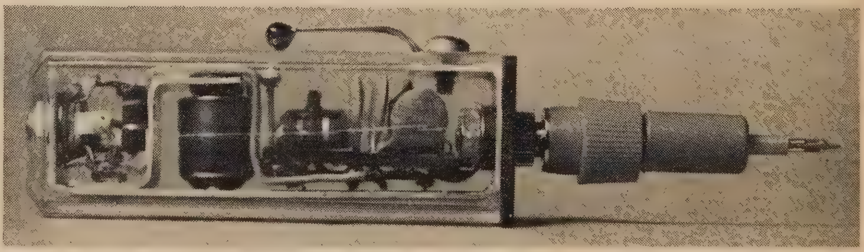


Fig. 1—Circuit of Tracex.



Tracex with probe tip, ready to go. Current drain is so small that no on-off switch is needed. Note that pocket clip is connected via screw to aluminum chassis.

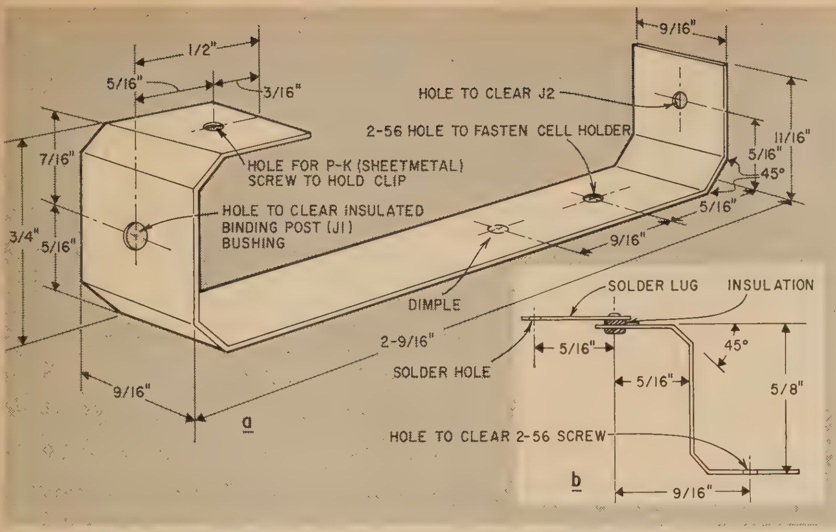


Fig. 2—Chassis (a) and cell-holder (b) construction.

voltage of 1,000, adequate for radio-receiver and carrier-telephone work. For a margin of safety, do not use the Tracex on dc over 500 volts or ac over 350.

Diode D does three things in the inject mode. First, it clamps the base of Q1 to saturate the collector on forward-bias (positive) peaks. This produces a narrow rectangular pulse of high harmonic content. The tone sounds like 750 cycles whether you inject at af or vhf.

Second, it prevents base-blocking Q1 by absorbing the reverse-bias portion of the feedback cycle and permitting full-amplitude pulses equal to the battery voltage.

Third, it allows oscillation even when the battery voltage has dropped to ⅓ volt!

In the trace mode the diode has two functions. The reverse-bias half-cycle of any ac wave at the input is clamped and only the forward-bias half-cycle is applied to base of Q1. (This is true only to an extent—I'll explain further in a moment.) This improves demodulation, and more audio reaches Q2.

The second function is to create a balanced load to equipment under test. This prevents noise and cross-modulation on multichannel carriers and also prevents intermodulation on high-quality program channels.

How can the Tracex amplify af or demodulate rf without some adjustment? Notice that there's no provision for fixed forward bias at the base of Q1. Yet, because of leakage, the transistor is not completely cut off. Thus there is, figuratively, a small "window" at Q1's base. It allows some class-A operation when the reverse-biasing half of the input cycle swings toward collector cutoff, then back through zero bias to the region where the base-emitter connection starts to absorb the forward-bias half of the input cycle.

Offhand, this looks like "class-A-prime" operation, but the diode bridged between base and emitter absorbs the reverse-bias half cycle, just as the base absorbs the forward-bias portion of the input wave.

The small "window" makes Q1 put out enough signal to drive Q2 to an output of 1 mw or more. Tracex *does* overload on strong af signals. The input level can be controlled: holding the instrument by the shell of the earphone plug minimizes pickup. Holding the case without touching Clip improves pickup. One finger on Clip increases input still more. Maximum signal occurs when Clip is connected to the common side of the circuit under test. (Sort of an anatomical volume control!)

Demodulation is very poor until the input signal level exceeds the limits of the "window" of class-A operation. Even so, sensitivity is such that it is impossible to trace an ac-powered radio without the Clip connected to chassis, because the rf from local broadcast stations will mask any test when the Tip touches any metal portion of the unit being tested.

Construction

The finished plastic case is ⅝ x 13/16 x 2⅝ inches, inside dimensions. It once contained a toothbrush, and comes in two sections. The short section is used for Tracex. If you spoil it, the long section can be used. Remove the lip with a mill file. The holes are drilled last to fit the chassis.

The chassis is formed from a strip of aluminum cookie sheet. Don't attempt to make square or even round folds. Use a small hand or bench vise to make two 45° bends for each fold. Drill holes after you fold. The long dimension of the chassis must be separated from the plastic case to clear the head of the 2-56 machine screw that fastens the mercury cell holder to the chassis. Fig. 2-a shows chassis dimensions, and Fig. 2-b the cell holder. The photos will help.

The mercury cell holder is a penlight cell holder cut in half and folded. (You get two chances on this operation, too!)

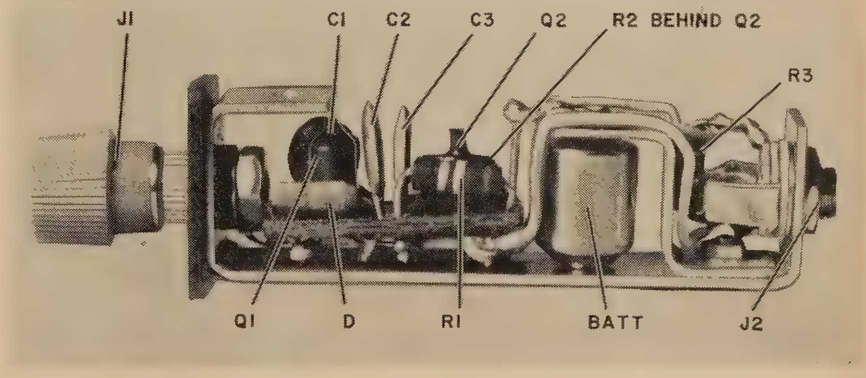
The circuit board is 1/16-inch Bakelite or phenolic insulating material, 9/16 x 13/16 inches. Fig. 3 is the bottom or wiring side of the circuit board.

Rubber-cement a piece of paper to the board. Make the layout exactly as shown in Fig. 3. (Holes for transistors vary with different types.) Prick and center-punch the holes. Use a No. 52 drill for the holes. Do not remove the drawing; it will be your guide for in-

C1—.002 μf, ceramic, 1 kv
C2, C3—.02 μf, ceramic, 50 v
D—1N67 or similar
J1—3-way or 5-way binding post
J2—Miniature closed-circuit jack
Q1—2N170 (G-E)
Q2—2N188-A (G-E)
R1, R3—2,700 ohms, ¼ watt
R2—150,000 ohms, ¼ watt
Plastic case*
Battery holder*
Pencil clip*
Test prod with banana plug*
600-ohm earphone or surplus R-30D*
Miscellaneous hardware*

Items marked (*) are described and illustrated in more detail in text, diagrams and photos

Locations of parts of Tracex.



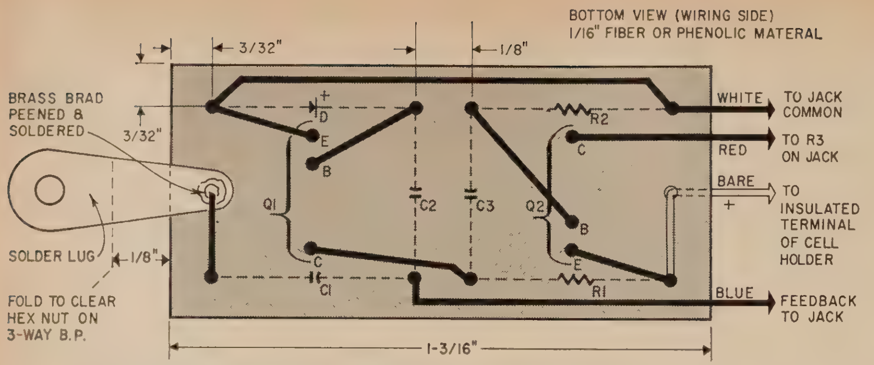

BOTTOM VIEW (WIRING SIDE)
1/16" FIBER OR PHENOLIC MATERAL
3/32"
1/8"
BRASS BRAD PEENED & SOLDERED
3/32"
SOLDER LUG
1/8"
FOLD TO CLEAR HEX NUT ON 3-WAY B.P.
D
E
B
Q1
C
C1
C2
C3
Q2
C
B
E
R1
R2
WHITE
TO JACK COMMON
RED
TO R3 ON JACK
BARE
+
TO INSULATED TERMINAL OF CELL HOLDER
BLUE
FEEDBACK TO JACK
1-3/16"

Fig. 3—Wiring diagram for Tracex. Layout is fairly critical, not for electrical reasons but for a mechanical one: tight fit.

serting and for wiring in the parts.

A large solder lug is riveted to the Tip end of the board. A little bit of paper must be removed here so the lug will lie flat against the board. The head of the rivet is on the top side; do the peening on the wiring side. Flow some solder on the peened area to lock lug and rivet together.

Study the photos and drawings so that the assembly of the three-way binding-post nut and lug relationship is firmly established in your mind. You must allow for insulated bushing, chassis and panel thickness. Cut off excess threads from the binding post.

The insulated panel is of the same stock as the circuit board, cut to 1 x ¾ inch with a hole drilled in the center to just clear the binding-post threads. This area is very important: it separates you from the lethal voltages applied between Tip and Clip. As you progress it will be necessary to assemble and disassemble several times to be sure everything slides in and out smoothly. A bare wire ties the positive terminal of the board to the positive mercury-cell holder lug.

The subassembly is rather tight with ½-watt resistors. Therefore, ¼-watt resistors are recommended. When you're through with assembly and wiring, remove the drawing by picking it up with a pin.

Apply a strip of insulating tape to the chassis where it faces the wiring side of the circuit board, to prevent accidental shorts.

Solder R3 to tip and sleeve of the monitor jack before installing the jack on the chassis frame.

Three long wires—red, blue and white—are soldered to the circuit board to carry Q2's collector, feedback and common to the resistor–jack assembly. These are the last connections made before inserting the mercury cell in its holder. Remember that the case of a mercury cell is positive.

The cell is one unit from an 8-volt transistor battery available even in drugstores. This battery is made up of six tiny cells and can be completely disassembled. They make nearly one year's supply for the Tracex. The cell in the photo was on the shelf more than a year before it was installed and, after 6 weeks of continuous use, its terminal voltage was 1.25 under load.

The optimum impedance for the earphone is 600 ohms. High-impedance crystal phones are not satisfactory. An 8-ohm earphone will work in an emergency. A magnetic one up to 2,000 ohms is better. The earphone shown is a surplus R-30D 300-ohm unit and is excellent in sensitivity and power handling. END

Two Tracex accessories: magnetic earphone (left) with plug to fit J2, and jar-top capacitive "sniffer", with banana plug to fit J1.

Foolproofing a PA System

THE COMPLAINT WAS LOW VOLUME and high distortion. I heard it several months before the problem was tossed into my lap, and can testify to the high distortion. The low volume was, perhaps, a matter of opinion. The athletic field where it is used is just across the road.

One side of the output transformer primary was open, with a pea-sized spot burned in the plastic coating between winding and core. Two other shops had worked on this outfit before I did, and the owner was both bitter and articulate about the results. Whether he was right or wrong, *my* shop does not need that sort of advertising. So I had to fix it.

The transformer was replaced, and one of the speakers plugged in. The speaker voice coil seemed to be cemented to its pole piece; it was impossible to insert a centering shim anywhere around its inner periphery. When the voice coil was removed, the trouble was apparent, though the reason for it was a mystery: half of the turns had been scraped down the bobbin and off the end in a big loop, without breaking the wire or even damaging the insulation! The bottom of the bobbin was constricted like a collet.

The second speaker, in the other half of the cabinet, had the same trouble, but now there was no mystery about it. The speaker cord was coiled neatly around its brackets, and the plug had been secured by jamming it between the speaker frame and cone!

Instead of "don't-do-it!" tags, I installed clips to hold the five-prong Amphenol speaker plugs. It is doubtful that anyone who would store a speaker plug inside the speaker could read, anyhow.

The problem of the output transformer remained. Multitap 40-watt jobs cost money, and it is unlikely that electrolysis ruined the original—what with all that plastic coating. More than likely, someone turned the amplifier on and banged the mike before he remembered to connect the speakers.

The speaker plugs have two prongs that could be shorted, and the sockets wired so that the amplifier would operate only when the speakers were plugged in. But high voltage could appear on those pins, and operating personnel must not be exposed to even a momentary hazard. Besides, this would prevent use of the output screw-terminal strip without the plug-in speakers.

Instead, I connected a 30-ohm 5-watt wirewound resistor across the 8-ohm winding, making a permanent partial load—something like one-quarter capacity. It has no apparent effect on either volume or quality.—*J. K. Bach* by Jack Darr

Service Editor

Service clinic

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 10011.

RESISTANCE MEASURING IS A BIG PART OF our work. One thing that'll throw you, if you're not watching for it, is "parallel paths." In modern TV circuits, they're like cousins: there by the dozens!

Even as far back as the Dumont 306, we had them. Look at Fig. 1. The resistances shown are those measured in an actual set in good working order. All resistors are well within tolerance. You can see one indisputable fact here: you can't measure resistance *accurately* if the resistor is still in-circuit. There is still only one way to measure: disconnect one end, *then* measure.

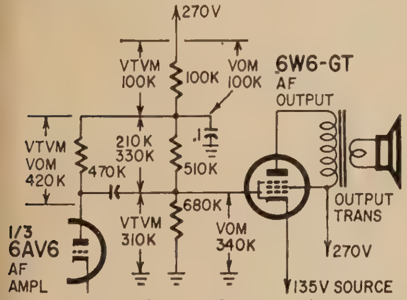


Fig. 1—"Stacked-B-plus" audio output stage has complex system of voltage dividers that can produce mysterious and misleading ohmmeter readings. Actual values of resistors are shown with ohmmeter readings obtained without disconnecting them.

Fig. 2 is the agc circuit of the same chassis. All resistors good, but look at the odd readings! Nothing even remotely approaching the correct value of the resistor.

So, what to do? Two things. One, cross-check against voltage readings in the circuit. For instance, if you read a very low resistance at a certain point, say in a plate circuit, but the B-plus voltage at that point is normal, then something is throwing your ohmmeter reading off. Please, *don't* take this as final, though—go on checking. I have seen many cases where a capacitor shorted and left a voltage reading normal. Never rely on the results of any *one* test. Cross-check.

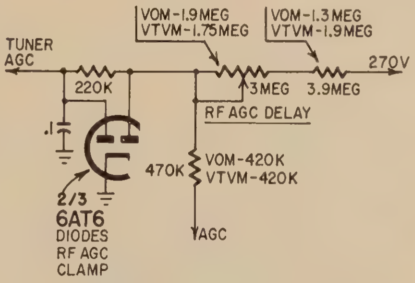


Fig. 2—Agc circuits are notable for their intricate high-resistance networks. Multiple paths and distant, "unseen" shunts produce peculiar readings.

Two, lift one end of any suspected resistor and measure its value. This is the only way you're going to get any valid information! Also, lift one end of any capacitors suspected of having small leakages. Same thing.

Why are these readings important? Because, in most cases, these resistors are part of *voltage dividers*. Look at the two resistors in the grid circuit of the 6W6-GT in Fig. 1. The 270 volts B-plus is fed to the top, and the ratio of the two resistors determines the grid bias on the 6W6. If you think that's not critical, change one resistor and see what happens!

Since the 135-volt line comes from the cathode of this stage, any bias change is going to have far-reaching effects, in stages apparently far removed: the video i.f., sync separators, video amplifiers, and so on—any stage fed from that 135-volt line. All from a drift in the value of a little resistor in the audio output grid circuit!

Large resistors used in 6BU8 agc circuits, etc., are just as critical. The big resistors connected between the B-plus and the agc line, f'rinstance: 6.8, 8.2, or even 10 and 20 megohms. If they drift, away goes the agc voltage. Never assume that one of these is good simply because "they're so big that a little drift won't hurt!" Not so. It will.

Instrument accuracy is another factor. Most service type vom's and vtvm's are well within the accuracy limits you need. However, it's a good idea to keep an eye on 'em. Get a surplus 1% resistor, say about a 1-megohm, like the one I use. Put this on your bench, and, every so often, reach up and check it. Since we use the ohmmeters on about a × 1K or × 10K scale for most of this kind of work, a 1-meg will give you about a center-scale reading, and this is where we need it.

In a few vtvm's low batteries will affect accuracy. Not in most, but keep checking just to be sure.

So, keep your eyes open, and don't forget to cross-check every time before taking a circuit all to pieces. It'll save a lot of time!

Pincushioning

I've got a funny one! The top lines of the raster and picture are straight, but the bottom half of the picture bows up. The owner says it's always been like this. The set is an RCA KCS-81J chassis.
—P. G., Johnstown, Pa.

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continued from page 57

the wrong direction! Most of this kind of trouble shows up at the sides of the picture, but it is quite possible for it to appear as you described it.

Believe you can correct this by installing a pincushion magnet at the bottom of the tube. Fasten it to the chassis, and move it around until the raster straightens out. A small pot magnet from a junked PM speaker can be used for this. Wrap a piece of solid wire around the magnet, and tape it in place. Fasten the end of the wire under a bolt on the chassis. The closer you set it to the yoke, the greater the effect. The final position must be determined by experiment.

Scope repair

I've built a new kit scope. It works very well, but the trace looks peculiar. Parts are thick and parts are thin (Fig. 3). Linearity is good, and the scope seems OK otherwise.—A. N., Manila, Philippines.

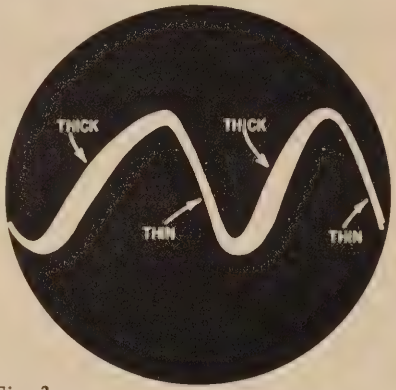

Fig. 3

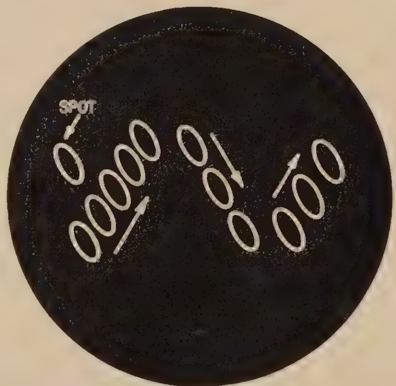

Fig. 4

The most likely cause would be astigmatism, as shown in Fig. 4. I have exaggerated this for illustration here. If the spot is a long oval, it would make a wide trace when traveling at right angles to the long side, and a thin trace when traveling the long way, as shown. Check this by turning your sweeps completely off, focusing the spot and checking it for roundness and minimum size. (Keep the brightness or intensity low or you'll burn a spot on the screen.)

Another possibility is the horizontal retrace blanking circuit. If it is switched on, you may be getting blanking when you don't want it. Trace the wiring to the horizontal sweep selector switch. Move the phasing control, and see if the thick parts of the pattern move along the trace. If so, the trouble is definitely somewhere in the horizontal blanking.

Slow-starting vertical oscillator

I'm just beginning to service TV's, and I've run into a problem. This is a G-E 21-137. I get a horizontal white line when the set is turned on; after about a half hour, the picture comes on.

I've changed the tubes, and got no improvement. Perhaps you can help me. —T. W., Baltimore, Md.

This trouble is obviously in a slow-starting vertical oscillator. Since you have changed the tubes, the trouble must lie in one of the components there.

Check the plate voltages (with the trouble present, while the set is cold). I believe you'll find something wrong right away in that section. A great deal of trouble like this is caused by bad plate load resistors, height and linearity controls and such components.

Check the height and linearity controls for "bad spots." Move them slightly while the trouble is showing up, and see if that doesn't bring the picture on. If so, replace the control. Since you say the set shows only a *thin* while line, this would put the trouble in the output stage, rather than in the oscillator, and a bad linearity control seems likely.

Conversion to new CRT

We'd like to convert a Philco 51T2136 from the present 20DP4-A to a more modern tube. What would you think about trying one of the new 23-inch types?—P. B. K., Baltimore, Md.

Conversions are practical if you don't try to go too far. If the original circuit was conservatively designed, with ample power reserve, we can get by. The greatest difficulty is in the increase in sweep *power* required—50% additional in the vertical and 25% in horizontal, to go from a 70° sweep system to a 90°. If the power supply components will stand this, we're all right.

All the 23-inch types you mentioned are 115° tubes. This conversion would probably be impractical, because of the far wider sweep needed. I'd use one of the many 90° types available. You'll have to replace the yoke with a 90° type having the same electrical characteristics: 10 mh horizontal, 45 mh vertical. Something like a 21CBP4-A would be quite all right, I'd say. END

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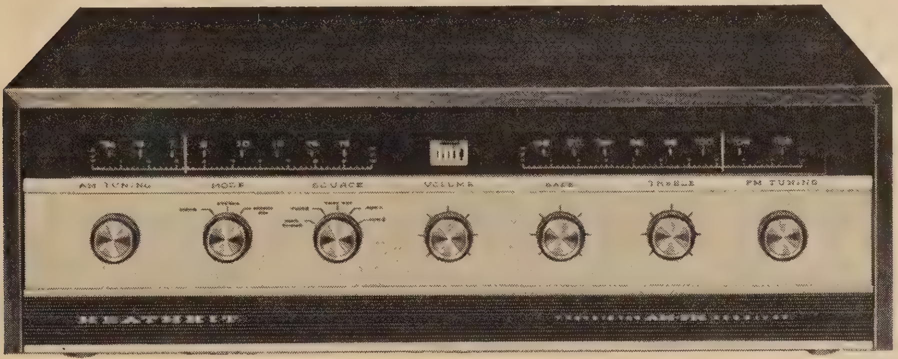

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Even if you can afford to buy the costliest model, you can't buy better performance. Start with the AR-13A's 43-transistor, 18-diode circuit. It's your assurance of cool, instant, "hum-free" operation; long, trouble-free life; and the quick, clean, unmodified response of "transistor sound" . . . characteristics unobtainable in tube types.

Next, there's wide-band AM, FM, FM Stereo tuning for distortion-free reception to delight the most critical ear. It has two preamps. And its two power amplifiers provide 66 watts of IHF Music Power, 40 watts of continuous sine-wave power. And it's all housed inside one luxurious, compact walnut cabinet . . . just add two speakers for a complete stereo system.

There are plenty of operating conveniences, too. Like *automatic* switching to stereo; automatic stereo indicator; filtered tape recorder outputs for direct "beat-free" stereo recording; dual-tandem controls for simultaneous adjustment of volume, bass, and treble of both channels; 3 stereo inputs; and a separate control for balancing both channels. The AM tuner features a high-gain RF stage and a high Q rod antenna. The FM tuner has a built-in line cord antenna plus external antenna connectors.

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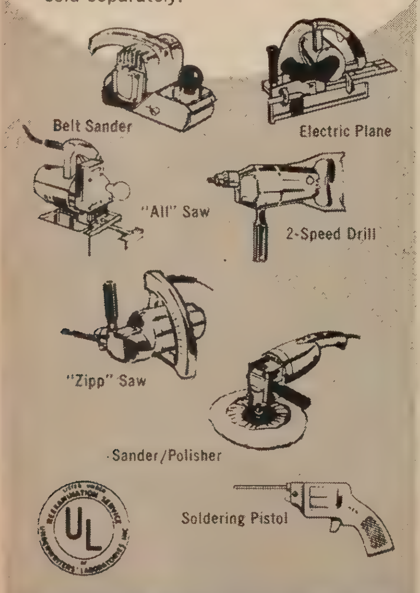

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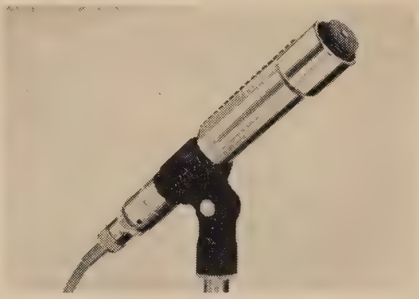
AUDIO EQUIPMENT REPORTS

Electro-Voice 676 Microphone



A LOT OF SOUND THAT FINDS ITS WAY onto tape during home recording sessions doesn't belong there. Home recordings often sound as if they were made in a cavern, with the voices of featured performers (Mom, Dad or the family dachshund) barely intelligible against a background of footsteps, refrigerator doors slamming a few rooms away, and buses roaring down a nearby superhighway. It's nice to think that you can stick an omnidirectional mike in the middle of a room and pick up everything going on, but it almost always turns out that there's more going on than you really want to record.

With the conviction that the sound a mike doesn't pick up is as vital as what it does capture, Electro-Voice has long made a specialty of highly directional microphones. The new E-V 676 is the latest in a long line of cardioid mikes, and a number of its features give it special appeal for critical audiophiles and PA users.

At a net of $60, the 676 is obviously no toy for a novice recorder owner. But anyone with a bit of experience with professional mikes will recognize that $60 is a low price for a *true* cardioid of good performance. And the 676 is just that. Unlike many so-called cardioids, it does not suddenly become omnidirectional from the low mid-range frequencies on down. There's more than one reason for the 676's good performance, but what's worth emphasizing most is the skill with which E-V has adapted the techniques used in its more expensive mikes to produce a really excellent directional characteristic.

The 676 achieves its directional pickup with the help of a series of slots along the top of its slim case. These slots channel sound from undesired directions in such a way that phase changes in the sound entering at various points and traveling through the case cancel out. Both the arrangement of the slots and the design of the mike's internal chamber help maintain the desired cancellation at all frequencies. For situations where background bass is troublesome, the 676 has a bass-cut switch with two positions (−5 db and −10 db at 100 cycles) of low-frequency cut.

You also have a choice of 150-ohm or high-impedance output, by moving one wire in the mike's cable connector. The 150-ohm position will prove extremely valuable to anyone who wants to take a recorder out "on location." The longer cable length allowed by the low-impedance output can make it possible to keep the recorder unobtrusive and out of harm's (and musicians') way.

The output level of the 676 is rated by E-V at −58 db, which in my language means that it will easily supply enough output for the low-level mike input of my Dyna PAS-3 preamp. The 676 comes, by the way, with a 16-foot cable.

Without a calibrated mike or anechoic chamber to work with, I checked the 676 on speech and piano to explore its cardioid pattern and overall frequency response. The results were excellent. In a close-miked recording, the family Steinway sounded clean and well defined, with no accentuation of the high end to produce a harsh or jangly quality.

Placed a bit further back, the 676 really proved itself. There's a low D on my piano that sets up a sympathetic resonance in the room and produces a subharmonic that makes the piano sound "bigger" than many a concert grand. The 676 got all of the added richness of the room sound onto tape without a hint of boomy accentuation of the bass, proving to my satisfaction that E-V's claim of directional low-end response is more than justified.

After a comparison of the 676 and my omnidirectional mike, I moved the 676 another few feet away from the piano and tried again. This time, results were not too good until I used the bass-cut switch on the 676. In the −5-db position, all sorts of boomy background noises seemed to disappear, and the loss of low-end response was not at all objectionable.

SPECIFICATIONS

(All specifications are the manufacturer's)

Type: dynamic
Frequency response: uniform 40 to 15,000 cycles
Polar pattern: cardioid
Impedance: 150 ohms balanced, or high (comes wired for high impedance)
Sensitivity: for 150-ohm impedance, −57 db (ref 1 mw/10 dynes/cm²); EIA rating −151 db. For high impedance, −57 db (ref 1 volt/dyne/cm²); EIA rating −152 db
Diaphragm: Acoustalloy
Cable: 16 ft 2-cond. shielded
Dimensions: 1¼ in. dia. x 7⅜ in. long including connector
Weight: 12 oz less cable
Price: $58.80 net

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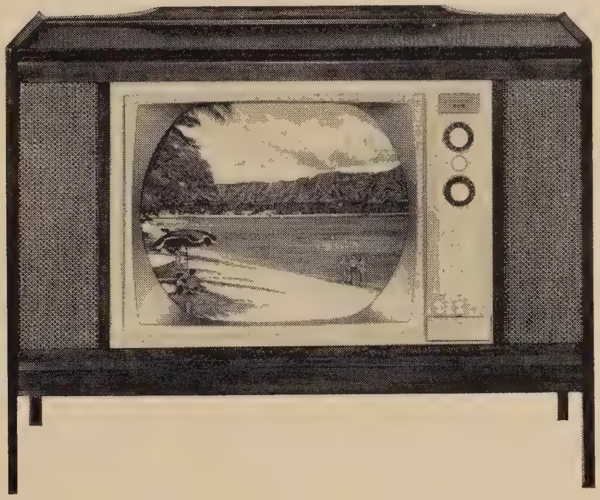

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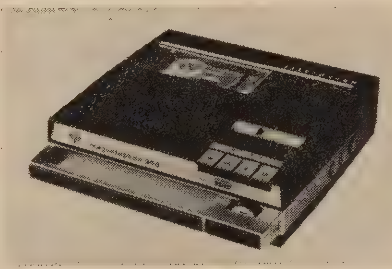
Next I tried some speech tests. As any recording engineer will testify, the human speaking voice provides a really rigorous test of a mike. The frequency and transient characteristics of speech are so random and complex that they tend to show up undamped resonances in any transducer very clearly. A mike with good low-end response often sounds slightly "chesty" on close-up speech. With that in mind, I left the 676's switch in the −5-db position and began with a test of the mike's close-up sound. The results were good—so good, in fact, that I never went on to check the −10-db position on the bass-cut switch. There was virtually no chestiness, and the mike had no tendency to "pop" on plosive sounds. At a distance of 5 feet, the mikes' directional characteristics gave the best results I've ever gotten in my listening room; definition was excellent, and there was no ominous-sounding bass background. I should add, too, that speech sibilants were clean-sounding both close to and away from the mike.

So the E-V 676 is not an economy mike for the casual recordist, but it is an excellent investment for anyone with a good recorder (and good associated hi-fi equipment) who wants to do more than tape records and radio broadcasts. It is definitely one of the small handful of best-buy mikes for the serious recordist.—*John Milder*

Telefunken "Magnetophon 300" Portable Tape Recorder



BATTERY-POWERED PORTABLE TAPE RECORDERS fall mainly into two groups. One is the popular, inexpensive kind—usually about $100—which are little more than glorified dictating machines, adequate for speech recording but incapable of doing justice to music. The other group, which includes the Swiss Nagra and the German Uher 4000-S, meets exacting broadcast standards and costs from $400 to $1200.

The all-transistor Telefunken Magnetophon 300, selling for $169.95, is a welcome attempt to fill the middle ground. It is aimed at the customer who needs a compact, portable recorder, convenient to carry, sturdy and reliable in operation. Its slim elegance (only 3 inches thick) and strikingly handsome styling make it as attractive to the eye as it is to the ear. Unlike some machines of its size and weight, the Telefunken 300 need not be confined to speech recording alone. With a frequency range of 40 to 14,000 cycles, constant speed and low distortion, this small portable is capable of quite creditable musical recordings. Granted, it cannot compete in fidelity with large machines. Nor is it meant to do so. Its principal virtues are handiness and versatility, with above-average tonal quality.

The Telefunken 300 I tested did these jobs admirably: *1.* Recording a business interview in a restaurant at lunch (good high-frequency response made the playback clearly intelligible despite noisy surroundings and the fact that the mike was simply left on the table without any attempt to bring it close to the persons). *2.* Recording dictation in a car during a long turnpike trip. (Its 90 minutes uninterrupted playing time eliminated the need to stop and flip over the reels.) *3.* Interviewing college athletes at a track meet. (Easy portability was a great help. Moreover, quality of voice reproduction was suitable for broadcasting over the local college station.) *4.* Recording a folk singer in a coffeehouse (where setting up a larger recording unit would have been inconvenient). *5.* Taping music off the air from FM broadcasts (with very satisfactory fidelity).

In all these workouts I was greatly impressed by the operating convenience of the 300. The fact that it takes 5-inch reels is a decided advantage over most small portables. With 90 minutes uninterrupted time on a single side of a triple-play reel I never worried about running out of tape at an awkward moment. Besides, remaining playing time can be read off instantly from a large scale. The keyboard controls are handy and don't need to be pampered. They seem quite sturdy and react with a firm,

SPECIFICATIONS

(All specifications are the manufacturer's)

Power: 5 D-cell flashlight batteries; rechargeable battery; line-voltage adapter; car-battery adapter
Reels: up to 5 inches
Tape speed: 3¾ ips, capstan drive
Frequency response: 40 to 14,000 cycles
Wow and flutter: less than 0.2%
Signal-to-noise ratio: better than 50 db
Tracks: two
Playing time: 3 hours (1½ per side) with "triple" tape
Rewind time: 900 ft in 3 minutes
Fast forward: 900 ft in 3 minutes
10 transistors, one diode
Inputs: Microphone (2,000 ohms, 0.15 mv); radio (2,000 ohms, 0.15 mv); phono (2 megohms, 0.15 v)
Outputs: speaker (3 to 8 ohms); preamp (18,000 ohms, 1.5 v); earphone (5,000 ohms, 0.4 v). Built-in 3 x 4-in. speaker
Bias & erase frequency: 63 kc
Drive: transistor-governor control, two flywheels
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Under These Beautiful Cabinets . . .

you'll find the most advanced solid-state circuitry. The magnificent Heathkit AJ-43 Stereo Tuner features 25 transistors and 9 diodes . . . wide-band AM, FM & FM Stereo to satisfy any listening wish . . . *automatic* switching to stereo plus an automatic stereo indicator light that signals when stereo is received . . . filtered left & right channel outputs for direct, beat-free stereo recording . . . separate AM & FM tuning meters . . . automatic frequency control to lock in desired station for rock-steady, drift-free reception . . . automatic gain control that eliminates "blasting" or "fading" of incoming signals, keeps volume constant . . . adjustable FM squelch to let you tune across the dial *without* annoying between-station noise . . . stereo phase control for maximum separation, minimum distortion . . . and a factory-built & aligned FM "front-end" tuner and 5-stage FM I.F. circuit board for quick, easy assembly!

Matching Heathkit AA-21 Stereo Amplifier!

This superb unit boasts a 26 transistor, 10 diode circuit that produces 70 watts continuous, 100 watts IHF music power at ± 1 db from 13 to 25,000 cps. And you enjoy complete freedom from microphonics, effortless transient response, and cool instant operation . . . characteristics unobtainable in tube-types.

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With its encapsulated, epoxy-covered circuit modules and five stable circuit boards, the AA-21's assembly is fast, simple and fun . . . requires *no* special skills or knowledge!

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Kit AJ-43C, tuner, 19 lbs.	*$129.95*
Kit AA-21C, amplifier, 29 lbs.	*$149.95*

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Prices & specifications subject to change without notice HF-177 positive snap. The transport mechanism responds quickly and smoothly, without jerking or any trace of tape strain.

Particularly effective is an instant stop-and-go control built right into the carrying handle. During interviews, this control enabled me to start the recorder to catch significant portions of a conversation while stopping it during lags—all without the person interviewed being aware of it.

The built-in speaker provides exceptionally clear speech reproduction. For music reproduction, I preferred to feed the output of the Telefunken 300 into a regular hi-fi system. There are inputs for high-impedance microphone and for direct connection from a radio tuner or the "tape-out" terminal of a hi-fi amplifier; outputs for external amplifier, external speaker and earphones. The built-in speaker can be switched off.

An optional 1⅞-ips speed might have been desirable for extra tape economy in speech recording, where fidelity is not a major consideration.

Inputs and outputs require German-style plugs, which can be an inconvenience when you are trying to make up some patch cords quickly. The necessary hardware is readily available from the local distributor, and once you have it, there's no need to worry about it any more.

The Telefunken 300 is powered by five standard flashlight batteries. The recording-level meter also acts as a battery indicator, showing when batteries need replacing. A rechargeable battery is optional, as is an external power supply that allows the recorder to be operated from ordinary house current (115, 117, 220 or 240 volts at 50 or 60 cycles). In cars, the unit can be plugged into the cigarette-lighter socket through an accessory Car-Adapter for either 6-volt or 12-volt systems. With a carrying case and a shoulder strap (also optional), the Telefunken 300 makes recording as simple and casual as taking snapshots.—*Hans Fantel*

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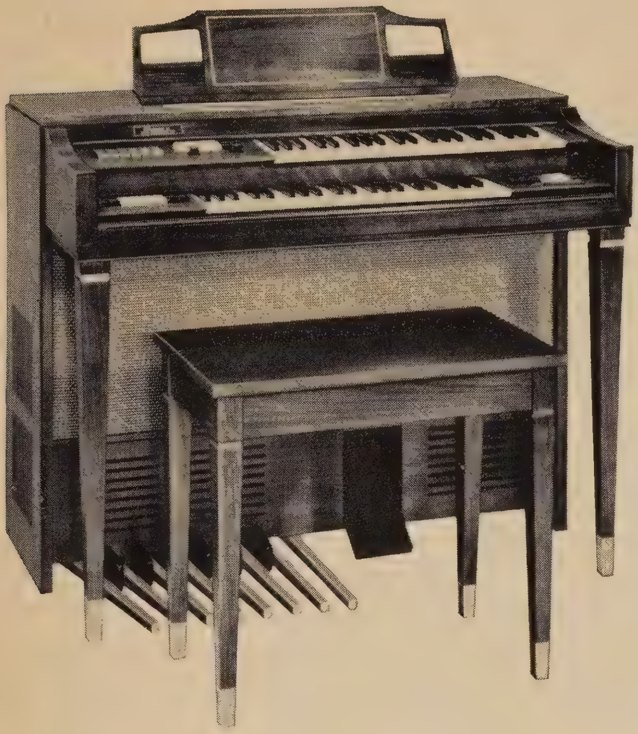

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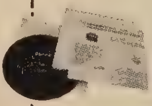

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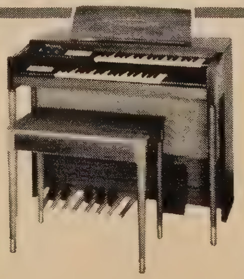

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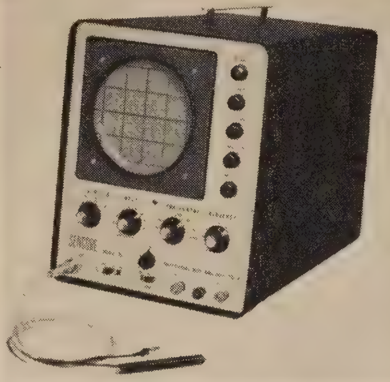


THE OSCILLOSCOPE IS THE TECHNICIAN'S most useful "weapon". It speeds servicing and trouble location by making tests no other instrument can. If a scope is designed to make tests faster than most, you may find yourself using it without hesitation, as readily as you'd use your vtvm.

Sencore's PS127 scope has been designed with speed in mind. Unnecessary controls have been eliminated, and the ones left are grouped so that they are "functionally related." This makes its operation a lot faster.

All the "display controls"—those that affect the basic pattern—are set in the upper right side of the panel, alongside the screen. From the top, they are: Intensity, focus, vertical positioning, horizontal positioning and horizontal gain.

SPECIFICATIONS

(All specifications are the manufacturer's)

Frequency response: Vertical—10 cycles to 4.7 mc. Rise time .07 μsec. Horizontal—10 cycles to over 400 kc.

Deflection sensitivity: Vertical—.017 volt rms/inch at direct terminal; 0.17 volt rms/inch at "low capacity" terminal. Horizontal: 0.9 volts rms/inch.

Input impedance: Vertical (at jack) 2.7 megohms shunted by 22 pf; through cable at direct probe terminal, 2.7 megohms shunted by 90 pf. Through cable at low-capacitance jack, 27 megohms shunted by 9 pf. Horizontal—4.5 megohms shunted by approximately 10 pf.

Sweep generator: Phantastron type; ranges continuously adjustable with approximately 10% overlap. Ranges: 5–50 cycles, 50–500 cycles, 500 cycles–5 kc, 5–50 kc, 50–500 kc. Sweeps for TV horizontal and vertical deflection waveforms (7,875 and 30 cycles, to show two cycles) are marked with H and V for fast selection.

Synchronization: to approximately 4 mc. Internal, external, line frequency. Adjustable between plus and minus.

Maximum input voltages: Vertical direct, 1 kv peak-to-peak with 1 kv dc; vertical lo-cap, 5 kv peak-to-peak with 1 kv dc. Horizontal, 30 volts peak-to-peak with 600 volts dc. Sync, 75 volts peak-to-peak with 500 volts dc.

Power consumption: Approximately 110 watts in operation; 54 watts in standby.

Dimensions: 11 inches high by 9 inches wide by 15½ inches long (deep).

Weight: 22 lb.

Price: $166.11

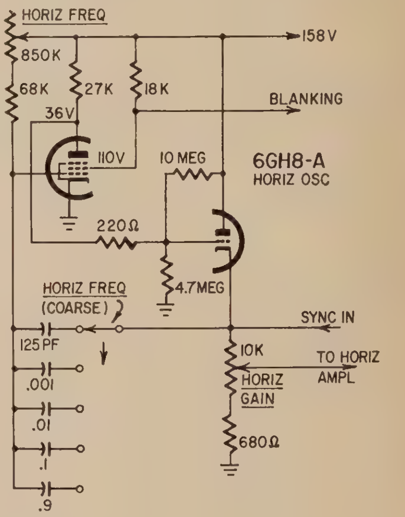
As the maker says, this allows "one-hand" operation and reduces the number of hand movements needed to adjust the pattern.

The vertical amplifier is wide-band, with a response from 10 cycles to 4.7 mc within 3 db. Input impedance, through the direct probe, is 2.7 megohms with 90-pf shunt capacitance. Sensitivity is .017 volt per inch.

A 10:1 low-capacitance probe is used. This bring the input impedance to 27 megohms and 9 pf of shunt capacitance, at a sensitivity of 0.17 volt per inch.

Patterns can be locked very simply by a "plus-or-minus" sync control with a single knob. Line and external sync can also be used, selected by a slide switch.

A phantastron oscillator is used to give horizontal sweep from 5 cycles to 500 kc. Five ranges are selected by a single knob, with a continuously variable vernier control next to it. The phantastron oscillator (see diagram) is a modification of the transitron circuit, like a monostable multivibrator. Advantages are easy positive triggering by sync, very good waveform and high stability. This is a circuit often used in TV station sync generators.



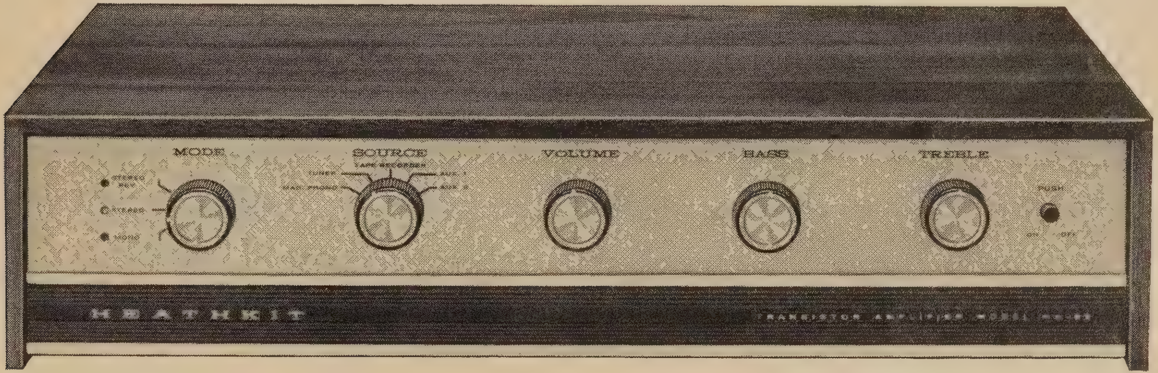
Phantastron sawtooth sweep generator in PS127. (Some switching details have been omitted.) Circuit is free-running, yet operates almost like triggered ("one-shot") sweep. Note high screen, low plate voltage on pentode.

On the sweep selector, V and H positions are marked, so that 30 and 7,875 cycles can be located easily, to display two cycles on the screen at TV vertical and horizontal sweep frequencies.

continued on page 72

"Until just recently, I have been somewhat skeptical about low priced transistor amplifiers. However, after testing and listening to the Heath AA-22, I feel it is time to revise my opinion. This remarkable amplifier can easily hold its own against any amplifier—tube or transistor—anywhere near its price range."

JULIAN D. HIRSCH, Hi Fi/Stereo Review, Nov. '64



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Let's Look Closer! The AA-22 provides 40 watts continuous, 66 watts IHF music power at ±1 db from 15 to 30,000 cps. Features 5 stereo inputs to handle mag. phono, stereo-mono tuners, tape recorders, & 2 auxiliary sources. There are 4, 8 & 16 ohm speaker outputs plus tape recorder outputs; a 5-position selector switch; 3 position mode switch; dual-tandem control; bass & treble controls.

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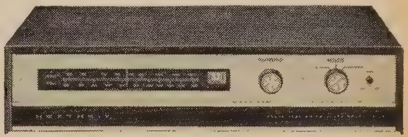

Matching AM/FM/FM Stereo Tuner

The above quote comes from July '64 issue of *Radio-Electronics*.

The matching AJ-33 tuner features a built-in stereo demodulator; AGC for steady volume; AFC for drift-free reception; stereo indicator light; stereo phase control for maximum separation, minimum distortion; filtered stereo outputs; tuning meter; flywheel tuning; voltage regulated power supply; illuminated slide-rule dial; and pre-built, prealigned FM "front-end" tuner and AM-FM I.F. circuit board for fast, easy assembly.

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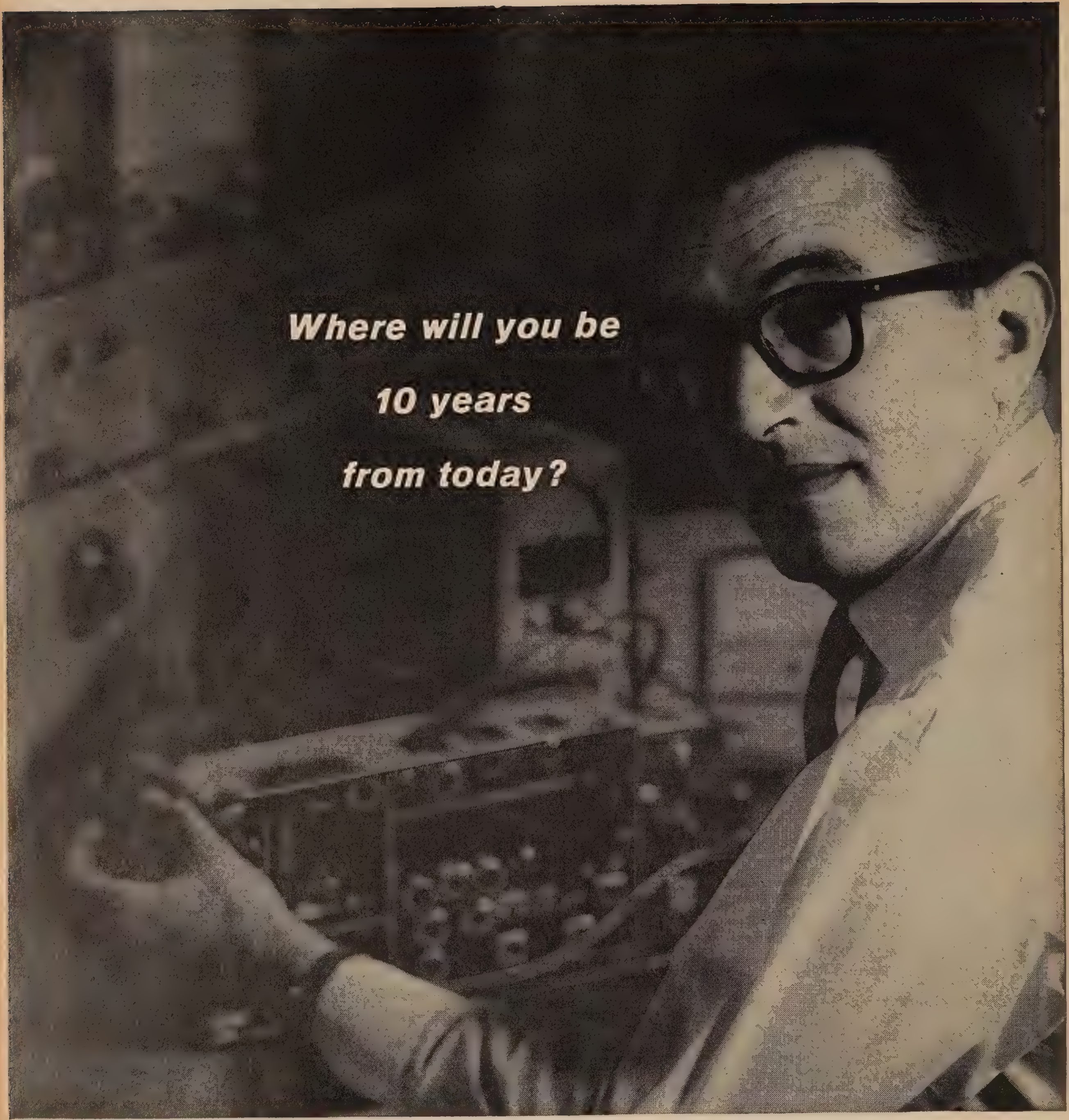

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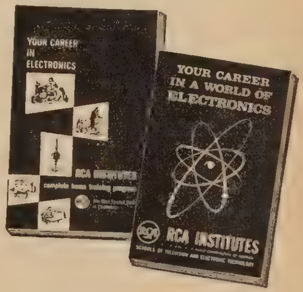
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continued from page 66

Peak-to-peak voltage measurements are very simple on this scope. The vertical controls are calibrated, the "step" control in ×0.1, ×1, ×10 and ×100, and the variable control from 0.5 to 5 volts. No calibration setup is needed. The waveform to be measured is simply adjusted to a 1-inch height, and the voltage read from the two calibrated knobs. For example, a setting of ×0.1 and 1.5 means "1.5 volts divided by 10, or 0.15 volts". The graticule is conveniently divided into sixteen ¼-inch squares, which will speed up p–p voltage measurements a great deal, and should prove very useful in servicing.

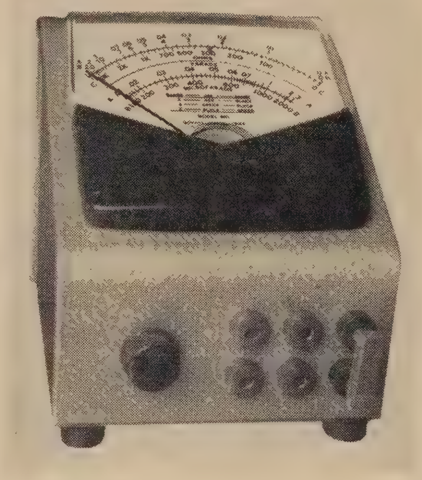
A novel double probe is supplied. The cable goes in at the center of the probe body. One end of the probe is "direct," and the other low-capacitance. You change from one to the other literally with "a twist of the wrist." A plug-in test prod and an alligator clip can be used in either end. Color-coded jacks help identify the different inputs.

Jacks for external sync input, ground and horizontal input are located in the lower right-hand corner of the panel. A three-position power switch with a standby position is at the bottom.

I checked this instrument for several days on all kinds of work, with very good results. Patterns were very stable, and drift was unnoticeable. I locked it to the video signal on a set and left it for several hours without losing sync. Resolution and brightness are very good; sync signals, color bursts, etc., are very easy to "read." Just as a gag, I displayed the rf carrier of a radio i.f. at 455 kc, and got a very steady sine-wave pattern.

A good safety feature of this instrument is a high voltage rating on the inputs: you can safely superimpose 1,000 volts p–p on 1,000 volts dc, to the direct input. Using the low-capacitance input, means that 5,000 volts p–p could be applied with 1,000 volts dc present. You still can't slap the probe directly on to the plate of a horizontal output tube, but who needs to? The higher voltage rating is a safety factor helpful in preventing accidental breakdown, for we *will* touch hot spots now and then without meaning to.

My overall impression was very good. The only change I'd make would be to wrap a piece of bright-colored tape all the way around the low-capacitance end of the probe for positive identification. That wouldn't take long. *—Jack Darr*



Conant Model 601 Ohm-Capacitance Meter

DID YOU EVER MEASURE THE RESISTANCE of a piece of hookup wire? Or of a set of switch contacts or relay points? If you were using a conventional ohmmeter, you no doubt got a zero reading. Our whole idea that there is such a thing as zero resistance in conventional conductors may have come from our "measurements" with conventional instruments.

The 601 opens up a whole new appreciation of small amounts of resistance. For example, a new slide switch I tested had a contact resistance of .08 ohm but turning it off and on a few times reduced it to about .015 ohm. A new relay that had been resting on the shelf for some time had a resistance of 0.6 ohm across a closed set of points! Burnishing the points with some brown paper reduced the resistance to .02 ohm, including the lead resistance connecting the points to the terminal block.

One test lead of my regular ohmmeter had .05-ohm resistance. To show just how expanded the scale of the 601 is, this represents about a three-quarter-scale reading on the meter! In fact there is a noticeable difference in meter reading between when the test prod *tips* are touched together and when the metal shanks of the tips are touched.

What are the advantages of reading low resistances? Of course, one main reason has already been mentioned—you can check the condition of switch or relay contacts. This is especially important when the contacts must pass high current or very low current. Excessive resistance across a set of points or contacts nearly always indicates poor reliability.

Some other significant measure-you can make are:

1. Resistance between a cable and a connector.
2. Resistance of fuses.
3. Resistance of coils with few turns of wire.
4. Resistance of solder joints.
5. Internal resistance of dry cells. (You must measure them in pairs, polarity series-opposing —either positives or negatives together.)
6. The resistance of a riveted or bolted connection.
7. The resistance of "hinge" connectors on swing-out speakers, etc.

No doubt many other uses will occur to a technician or engineer, depending upon his particular interest. As an example, automobile points may be checked—a good set of points should have less than .01-ohm resistance.

The novel circuit of the 601 (see diagram) was developed by Conant Laboratories and a patent on it has been applied for.

Transformer T1 supplies an extremely low voltage (.035 volt on range A, 0.35 volt on range B) to a low-impedance measuring circuit which in turn is coupled through T2 to the relatively high-impedance rectifier and meter circuit. Because of the low voltage, even very small resistances affect the coupling efficiency between the transformers to a considerable degree. The nonlinear response of the circuitry is accentuated by T2, and the meter scales are expanded so that as little as 1% resistance change is observable on the meter.

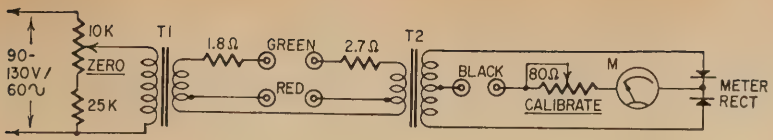
Less than 1 watt of power is used, so the unit may be left connected permanently to the power line. No on–off switch is provided.

The 10,000-ohm pot in the primary circuit of T1 is the zero-set. The 0–80-ohm adjustment in the meter circuit is for calibration. The 1.8- and 2.7-ohm resistors in the B-range circuit are also for calibration, done before the unit leaves the factory.

The instrument ranges and the connections of the test leads and shorting bar are printed on the meter face for handy reference.

Capacitor checking

Since ac is used in the measurement circuit, large values of capacitors



may be checked on the A- and B-ranges with the same test lead and shorting-bar terminations. The A-range will measure capacitors from 10,000 to 300,000 μf (.01 to 0.3 *farad*). The B-range will measure capacitors from 100 to 3,000 μf. Be sure, when measuring capacitance, to check the capacitors right at the terminals, since any appreciable lead length will cause a low capacitance reading due to the lead resistance.

RANGE	USE	SHORT
"A" 0-.2Ω 10,000-300,000μf	RED	BLACK
"B" 0-20Ω 100-3000μf	GREEN	BLACK
"C" 0-20K	BLACK	GREEN

Inductance checking

Although there are no scales on the meter for measuring inductance, I did some interesting experiments with speakers and transformers. For example, a particular transistor transformer which read 1 ohm from the center tap to an outside lead on a regular ohmmeter read 3½ ohms on the 601, indicating its increased impedance at 60 cycles. Still more interesting was that across the entire winding the reading on a dc ohmmeter was 2 ohms while on the 601 it was approximately 12 ohms, showing the additional impedance of the two windings in series with mutual coupling.

I checked several speakers for impedance at 60 cycles. They read very close to what they did on a regular ohmmeter, no doubt because most speakers have so little inductance that it is not a factor at 60 cycles.

So it really works. One precaution you must observe: make near-perfect connections to the device you test, otherwise the resistance of the connection may lead to an erroneous reading. Scrape the terminals bright and cover as much area as you can with the test prods. Then all readings should be within 5% at 25°C on A and B scales. The C-range is a "dc" indication and was added for utility measurements. Its accuracy does not exceed about 15%. Because it is a dc range, capacitors cannot be measured with it.—*Wayne Lemons*

Use Thin Dial Cord In Fisher FM-90X

A customer brought in a Fisher FM-90X tuner with the complaint that the tuning mechanism would operate only on the right half of the slide-rule type dial. The original dial cord had broken and the customer had replaced it according to service instructions from the manufacturer.

We found that when the tuning shaft was rotated, the cord would wind to the end of the shaft and double back on itself. We restrung the tuner with extra-thin dial cord and the set worked perfectly. With the thin cord, the loops on the shaft would travel a shorter distance along the shaft while winding, thereby allowing the pointer to traverse its path completely without binding the mechanism.

We've made it policy now to use the extra-thin dial cord on all restringing jobs.—*Phil Baskin*

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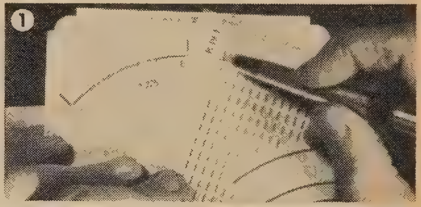

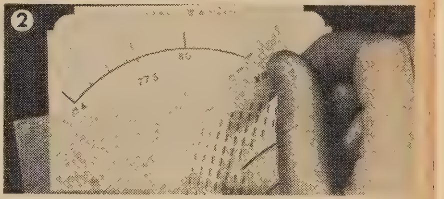

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† Section of full-length article
§ Transistorized

CI	Service Clinic
Corr	Correction
Corres	Correspondence
NB	News Briefs
NC	Noteworthy Circuits
Pat	New Patents
Tech	Technotes
TTO	Try This One
WN	What's New

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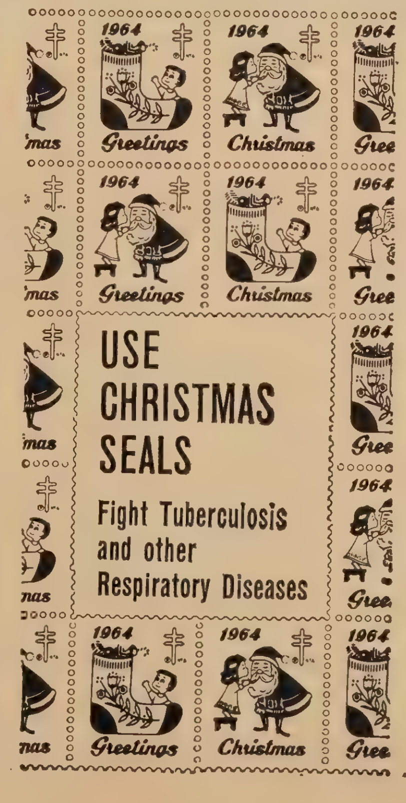

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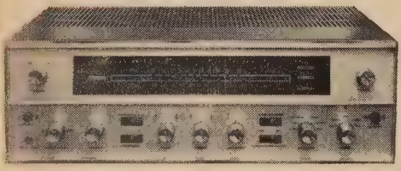

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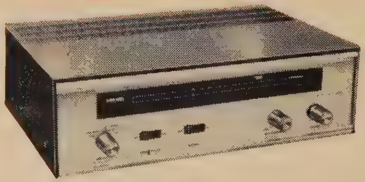

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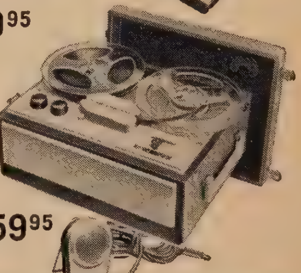

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Model RK-142 Deluxe Portable Tape Recorder perfect for the home, school, or office. Records and plays ½ track monaural at two speeds. Specially designed lever type motion switch gives fool-proof operation. Complete with dynamic microphone, connecting cables, and empty 7" reel. Imported, **99-1512WX.**

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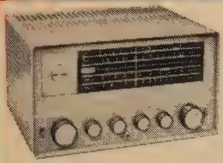
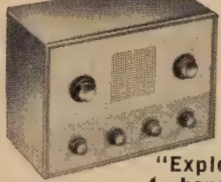


64^{50}

Deluxe Model HA-63 Shortwave Receiver is an excellent choice for the beginning shortwave listener or novice amateur. Covers 550 KC to 30mc in 4 bands and features electrical bandspread on all frequencies. 7 Tube circuitry gives outstanding selectivity and sensitivity. Imported, **99-2534WX**



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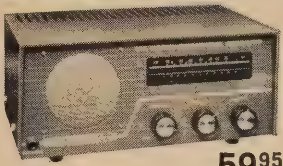

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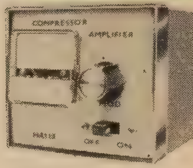

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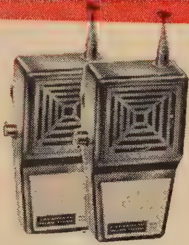
Model HA-85 6-Transistor "Walkie-Talkie" transmits and receives up to 1 mile. Ideal for sports, boating, construction and recreation. Complete with leather case, earphone, batteries, and crystals for the channel of your choice. Imported, **99-3013CL.**



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The HA-70A—a wired pocket-size 3-transistor walkie-talkie with countless exciting short range applications. Complete with crystal, carrying case, and 9-volt battery. Imported, **99-3011L.**

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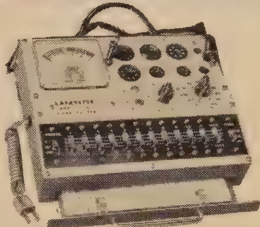

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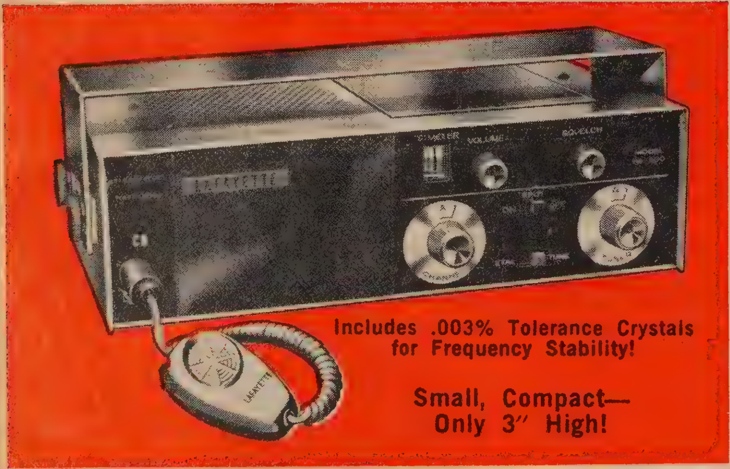

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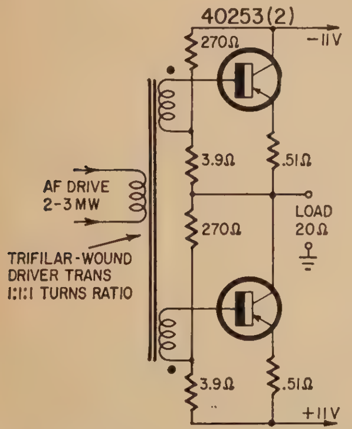
New Semiconductors and Tubes

NEW TRANSISTOR FILLS HI-FI "POWER GAP"

For several years a few transistors could be counted on to produce 15 to 25 watts of wide-range, low-distortion audio reliably, connected in some kind of push-pull class-B circuit. It was also quite easy to design wide-range, low-power amplifiers, for speakers in quiet rooms or for earphone use—with a few hundred milliwatts of output power. But, until now, the designer who wanted 2 to 5 watts for a package phono system or for driving higher-power stages without strain had to shop around in the rarefied reaches of servo and switching "semi-power" transistors, or make do with high-power jobs—often expensive for the purpose.



RCA has just announced the 40253, germanium alloy-junction p-n-p transistor intended specifically for low-power hi-fi audio work: 2.5 watts output in the now-famous "single-ended push-pull" class-B circuit (see diagram). This at collector-to-ground (center) voltages of ± 11 and maximum-signal average collector current of 159 ma—an efficiency of more than 70%.

The best news is that this transistor is in the small TO-1 case with leads insulated from the case. No heat-sinking problems.

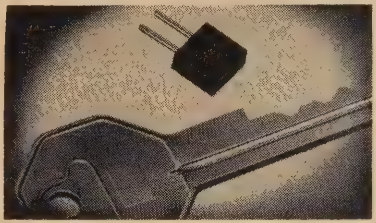
Maximum collector-to-base and collector-to-emitter voltages are 25. Maximum collector current, 500 ma; maximum base current, 100 ma; maximum total dissipation at case temperatures up to 64°C, 650 mw. It features exceptional linearity of dc beta over its entire collector current range.

SOLID-STATE CURRENT LIMITER

A new solid-state cermet (ceramic /metal) current limiter that offers positive and predictable protection for semiconductors has been announced by Electra Manufacturing Co.

Typed the P-400, the new device is three to four times faster than any other protective device, nearly vibration-proof, and clears (resets) in less than a millisecond at 316% of rated current.

Response speed is increased with temperature, tightening protection in proportion to the needs of the semiconductors, which are more vulnerable as temperature rises. The temperature coefficient of the P-400's is + 2,500 parts per million per °C. Cold resistances of .022 to 13.5 ohms are available, rising to 10,000 megohms after firing. The units measure ¼ × ¼ × ⅛ inch and come in current ratings of 1/16 to 5 amperes. Price is in the $10 region.



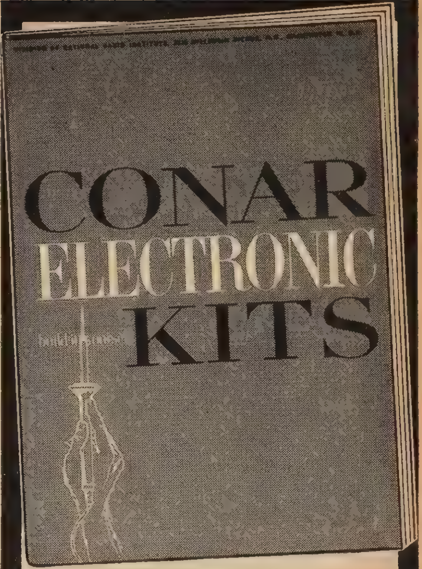
TRANSISTOR HAS NEAR-ZERO INPUT AND OUTPUT CAPACITANCES

To fill the demands of micropower switching, a new technique has produced a transistor whose maximum input and output capacitance is 0.7 pf—of which 0.3 pf is contributed by the TO-18 header it's mounted on! The device was developed by Motorola.

Micropower logic refers to switching circuits that operate with collector currents in the microampere range. Until now, designers of such circuits were hampered by high transistor capacitances. Turning transistors on or off requires that the charge stored in these capacitances be removed by the turn-on and turn-off currents. Since the currents in micropower circuits are so tiny, relatively long times were needed to remove the charges. For that reason, micropower switching speeds were limited to 10 or 20 kc. With the new 2N3493, they can purr at 1 mc or better.

The extremely low capacitances are produced by making the active area of the transistor so small that it cannot be seen with the naked eye—in this case, an area of 0.8 square mil—smaller than the cross-sectional area of a human hair split lengthwise into quarters.

Transistors built like that offer interesting possibilities as small-signal rf amplifiers, for they might be able to work near their maximum available gain figures without neutralization. END



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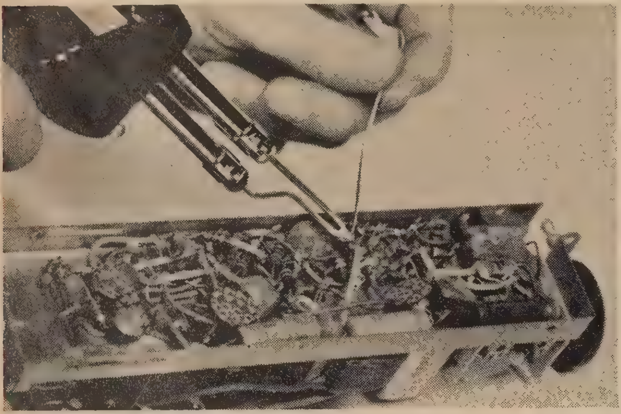
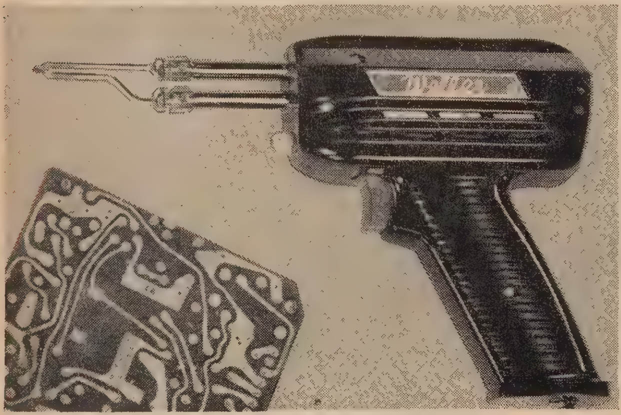


AVOID USING TOO MUCH SOLDER

Apply just enough solder to make a secure connection. Excess solder may fill up tube sockets, freeze switches or cause short circuits.



USE A DUAL HEAT GUN

Use the low heat trigger position to prevent damage when soldering near heat-sensitive components. Switch to high heat only when needed.

Weller Dual Heat Guns are invaluable for making fast, reliable, noise-free soldered connections. They're just as essential to hi-fi kit builders as they are to professional TV and radio service technicians. Two trigger positions permit instant switching to high or low heat. Tip heats instantly and spotlight comes on when trigger is pulled. Long reach tip gets into tight spots.

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TECHNOTES

ADMIRAL CHASSIS 16F1 AND 16AF1

Complaints were intermittent sound, loud intercarrier buzz, at times accompanied by critical vertical and horizontal hold control adjustments. Contrast and picture detail were poor.

The intermittent sound was traced to an intermittent 330,000-ohm resistor feeding the plate of the 3DT6 audio detector (Fig. 1).

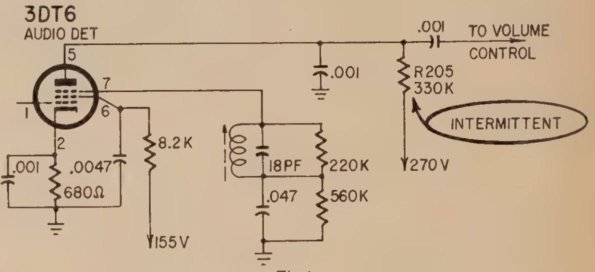

3DT6
AUDIO DET
5
7
6
1
2
.001
.0047
680Ω
8.2K
155V
18PF
220K
.047
560K
.001
.001
TO VOLUME CONTROL
R205
330K
INTERMITTENT
270V

Fig. 1

The scope pattern indicated severe clipping, especially of the vertical sync pulses from the plate of the 6AW8-A video output section (Fig. 2). This circuit was a likely suspect for the other complaints. The screen voltage of the 6AW8-A was about half of what it should be, and the plate voltage was somewhat low—around 45. The 5-μf electrolytic, one of the screen bypass capacitors, was the culprit—leaky. Replacing it improved things considerably.

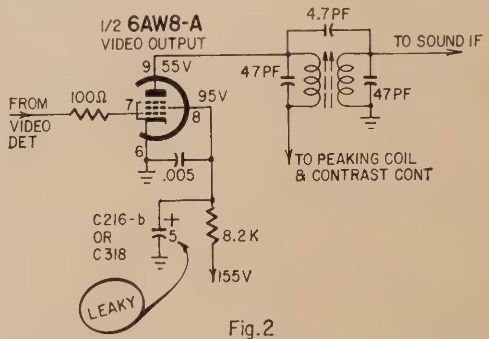

1/2 6AW8-A
VIDEO OUTPUT
9
55V
FROM VIDEO DET
100Ω
7
95V
8
6
.005
C216-b OR C318
+
5
8.2K
155V
LEAKY
4.7PF
47PF
47PF
TO SOUND IF
TO PEAKING COIL & CONTRAST CONT

Fig. 2

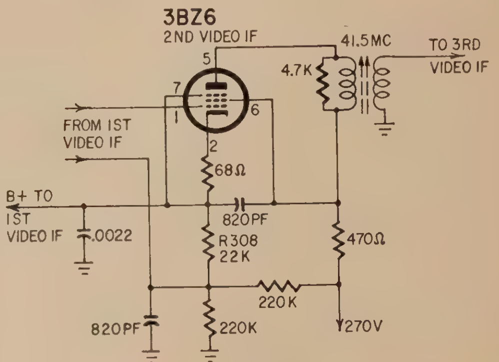
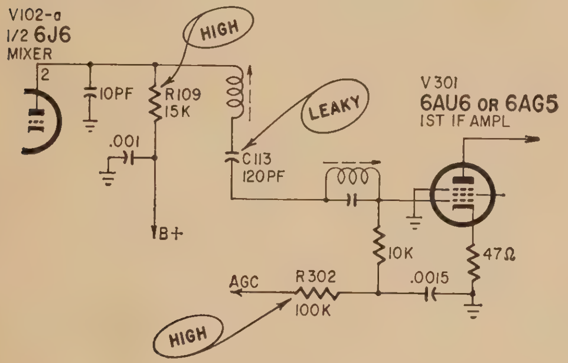

3BZ6
2ND VIDEO IF
5
7
1
6
2
FROM 1ST VIDEO IF
68Ω
B+ TO 1ST VIDEO IF
.0022
820PF
R308
22K
470Ω
220K
820PF
220K
270V
41.5MC
4.7K
TO 3RD VIDEO IF

Fig. 3

There was still some buzz and the picture detail was poor, indicating lack of high-frequenty response in the video circuit (Fig. 3).

After preliminary checking, I used a sweep generator and scope to examine the video i.f. response. The high-frequency response was poor. The 22,000-ohm resistor was the culprit. It had increased greatly in value, shifting the bias on the 3BZ6 second video i.f. and also affected the first video i.f.—they are connected in a stacked circuit. Replacement and a slight touchup alignment resulted in the best picture and sound the customer ever had.—*George P. Oberto*

ADMIRAL CHASSIS 20T1: MULTIPLE FAILURES

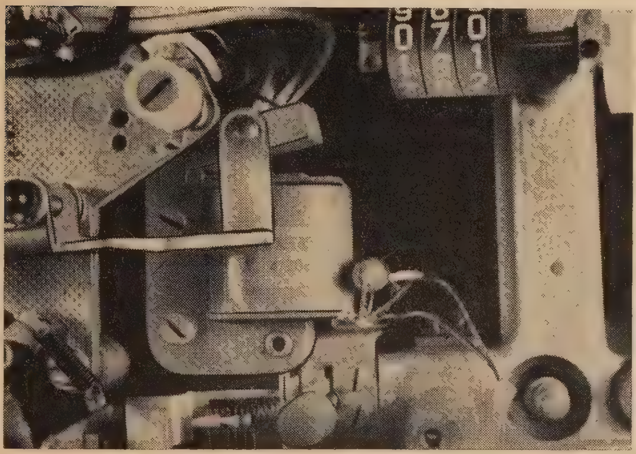


Symptoms: weak audio, no picture, visible vertical retrace lines.

Test results: positive voltage on control grid of the first i.f. stage, V301. Pin 2 of the 6J6 mixer half, the plate, read only 10 volts. I found R109 had doubled in value. R302 had risen to 150,000 ohms.

This suggested that C113 might be leaky, causing the resistors to pass too much current and change value. It was—but it took a resistance-capacitance bridge to show the leak. C113 shorted altogether when 75 volts was applied. Replacing it, and the two off-value resistors, cured the trouble.—*Mac Semons*

UHER TAPE RECORDER FAILS TO START



After a few hours' use this Uher Stereo III would sometimes refuse to start when the forward key was depressed. We found that the trouble was caused by the capstan-control electromagnet heating up after some time. Its electrical resistance increased to the point where the magnet no longer drew enough current to pull the capstan mechanism toward itself.

The only solution was to adjust the magnet's position until the capstan operated satisfactorily with the line voltage at 130—the highest it ever went in that area.

Be careful not to disturb the initial capstan pressure when you adjust the magnet.—*Steve P. Dow*

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The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction, servicing, basic Hi-Fi and TV repairs, code, FCC amateur license requirements.

You will learn how to identify radio symbols, how to read and interpret schematics, how to mount and lay out radio parts, how to wire and solder, how to operate electronic equipment, how to build radios. Today it is no longer necessary to spend hundreds of dollars for a radio course. You will receive a basic education in radio, worth many times the small price you pay, only $26.95 complete.

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The Progressive Radio "Edu-Kit" was specifically prepared for any person who has a desire to learn Radio. The "Edu-Kit" has been used successfully by young and old in all parts of the world, by many Radio Schools and Clubs in this country and abroad. It is used for training and rehabilitation of Armed Forces Personnel and Veterans throughout the world.

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The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore, you will construct radio circuits, perform jobs and conduct experiments to illustrate the principles which you learn.

You begin by examining the various radio parts included in the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set, you will enjoy listening to regular broadcast stations, learn theory, practice testing and troubleshooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are 20 Receiver, Transmitter, Code Oscillator, Signal Tracer, Signal Injector, Square Wave Generator and Amplifier circuits. These are not unprofessional "bread board" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

In order to provide a thorough, well-integrated and easily-learned radio course, the "Edu-Kit" includes practical work as well as theory; troubleshooting in addition to construction; training for all, whether your purpose in learning radio be for hobby, business or job; progressively-arranged material, ranging from simple circuits to well-advanced topics in Hi-Fi and TV. Your studies will be further aided by Quiz materials and our well-known FREE Consultation Service.

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You will receive all parts and instructions necessary to build 20 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hookup wire, solder, selenium rectifiers, volume controls, switches, knobs, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio & Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to the F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, and a High Fidelity Guide and Quiz Book. Everything is yours to keep.

J. Statatis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

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It is understood and agreed that should the Progressive Radio "Edu-Kit" be returned to Progressive "Edu-Kits" Inc., for any reason whatever, the purchase price will be refunded in full, without quibble or question, and without delay.

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LOOSE TUNER ROTOR SECTION, ADMIRAL 14YP3C, ETC.

The usually recommended way of fixing a loose rotor section in these tuner assemblies is to drill through the shaft and insert a pin. But often the parts shift slightly, and you end up with an error in alignment of the tuner contacts.

An easy way to insure correct contact position is to turn the set on and switch it to some channel. Position the loose rotor to its correct point. Clean the shaft and rotor with a service cleaner and apply an epoxy resin cement. Recheck the contact position, with the set still on so you can see the picture. Shut the set off and let the repair dry overnight.

Now you can drill the shaft and insert a pin without worrying about shifting. I have repaired tuners this way without pulling the chassis.—*Ken Bistarkey*

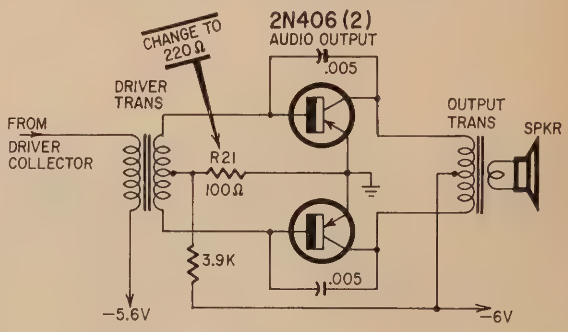
COLLAPSING RASTER IN SYLVANIA TV'S

If the raster pulses, collapsing to a horizontal line and filling out again, check the cathode resistor of the output section of the 10EG7 vertical oscillator–output tube. Usually a 330- or 470-ohm resistor, it may be open.

My theory about how this trouble symptom works is this: With the cathode resistor open, the cathode bypass capacitor charges through tube leakage and soon the cathode has nearly the same potential as the plate. Now there is no conduction, and the screen shows only a horizontal line.

Because the voltage across the capacitor under this condition is much higher than its rating, its internal leakage is high, and soon the voltage drops enough to allow the tube to conduct slightly. When it does, the raster fills out, but the capacitor has begun to charge again, and so on.—*W. G. Eslick*

DISTORTION, POOR RECEPTION IN ADMIRAL 7V1 PORTABLE RADIO



Replace resistor R21 (see diagram) between the audio driver-transformer center tap and ground with a 220-ohm unit. If possible, use a resistance decade, substitution box or a 500-ohm pot to find the best value.—*James E. Novak*

POOR OR INTERMITTENT HORIZONTAL HOLD

Some sets, particularly old Sylvanias, use a multivibrator type of horizontal oscillator with the ringing coil the only means of adjusting frequency. All other parts values are fixed. This is fine as long as those parts have a natural frequency around 15,750 cycles. If they are far off, the ringing coil must be adjusted to compensate. This is not good, because the afc circuit will be hard put to provide decent sync, and the oscillator may "take off" in the presence of noise.

When I run into off-value, off-frequency trouble in circuits like this, I short out the ringing coil and temporarily replace the oscillator grid resistor with a variable resistor, which I adjust for a stable picture. Then I unshort the ringing coil and adjust it for best stability. I remove the varia-

Coming Next Month

Radio-Electronics

COLOR TV ISSUE

Here are just some of the features which will be in the issue:

- Fundamentals of color servicing—a primer for the service technician facing his first color television receiver.
- Prospects for new, different color picture tubes—what lies ahead.
- What's happened to the various one-gun tubes proposed in the past?
- An analysis of the new 25-inch rectangular tubes.
- A rundown on the latest color test equipment.
- Case histories on servicing color.
- Pitfalls to watch for in setting up color TV test equipment.
- Why a consumer should buy color now—including all the facts needed to sell color TV.
- Is obsolescence a problem?
- A report on color television around the world.
- A complete directory of color TV receivers, listing manufacturers, specifications, sizes—a valuable reference for set owner and service technician alike.
- A working glossary of color TV terms.

JANUARY ISSUE on sale December 17

ble resistor, measure it, and replace it with a fixed resistor near that value. Then I touch up the ringing coil. This often cures persistently drifting pictures.—*Ed Pugh*

MYSTERIOUS HUM IN 21-INCH FIRESTONE TV

We had repaired and checked this set with our test CRT. As soon as we substituted the customer's tube, a loud audi hum appeared. With the test tube back in, the hum went away.

Checking the customer's tube showed a short fron cathode to control grid. Our checker wouldn't remove th short, so we resorted to the ancient trick of grounding th cathode of the CRT to chassis, taking the high voltage of the second anode lead and making contact with all pins except the heater pins.

This removed the short, and with it went the audio hum.

We figured the video signal with hum was being fed bacl in the audio circuit via the sound takeoff transformer in th video amplifier plate circuit.—*Harry J. Miller*

LEAKAGE CAUSES POOR AM RECEPTION

A small ac-dc radio, playing very poorly, showed positive voltage on the input grids of the mixer and rf stages which return to the avc bus. Tubes checked OK.

The trouble was leakage between windings of the i.f transformers. A quick check is to short the avc bus to B-minus. If operation is restored, this may be considered a temporary repair. However, replacing the i.f. transformers is th only permanent cure. Remember to recheck and realign th new transformers after replacement.—*Herbert Greenberg*

SMALL SPOT WELDERS

When servicing the electronic timer of foot-operatec spot welders, first locate the two leads from the normally open pedal-actuated switch.

To initiate the welding cycle for test purposes, jump these two leads instead of operating the pedal. This prevents damaging the electrodes.—*R. C. Roetger* END

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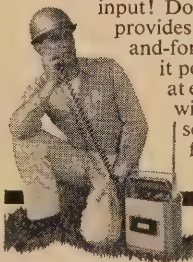

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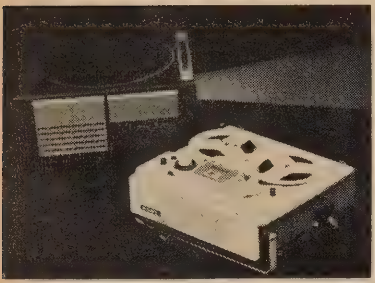
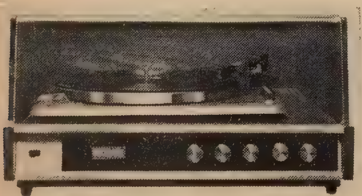


PHOTO/SYNC TAPE RECORDER, *211-TS,* with built-in slide projector synchronizer programs automatic slide advance with recorded narration and music background. Build your own sound library to match your slides. Response: 70–8,000 cycles at 3¾ ips; 70–4,000 cycles at 1⅞ ips. Weight 10 lbs.—**Sony/Superscope,** 8150 Vineland Ave., Sun Valley, Calif.

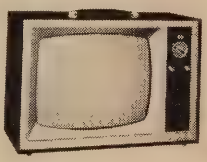
IN-CIRCUIT CAPACITOR TESTER KIT, *model KB-147,* checks bypass, coupling, blocking and filter capacitors of all types including electrolytics without removing them from circuit. EM84 eye tube. Indicates in-circuit electrolytic capacitance from 2 to 400 μf in two ranges. Leads, assembly instructions and operating manual. 7½ x 5⅜ x 4¼ in. 110–120 volts ac, 60 cycles.—**Olson Electronics, Inc.,** 260 S. Forge St., Akron 8, Ohio.



COMPONENT-QUALITY PHONOGRAPH, *model Stereo 200.* Table model is 18½ x 16 x 9½ in., Plexiglas lid and walnut cabinet. 18 watts per channel IHF; distortion less than ½% at rated output; frequency response 10 cycles to 22 kc ±1 db; 30 cycles to 12 kc power bandwidth at 1% distortion; separate bass, treble, volume and balance controls, mode selector; auxiliary inputs for tuner or tape; tape output jacks.—**Benjamin Electronic Sound Corp.,** 80 Swalm St., Westbury, N.Y.

NEW TEST LEADS, *model VL-750,* will add extra range up to 750 volts ac to the Amprobe rotary-scale, clamp-on volt-amp-ohmmeter, multiplying 150-volt scale readings by 5.—**Amprobe Instrument Corp.,** Dept. VL-750, 630 Merrick Rd., Lynbrook, N.Y. 11563

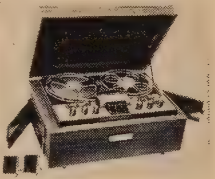
19-IN. PORTABLE TV SEMI-KIT, 4-mc bandwidth, black-and-gold metal cabinet, all alignment done at factory. Has power transformer for line isolation and two printed-circuit boards on which most of components are mounted and wired. 24 x 13 x 17⅝ in., 54 lb. Licensed by RCA, can be supplied for 50 or 60 cycles, 220 volts. 19AFP4 picture tube.—**Arkay International, Inc.,** 2372-82 Linden Blvd., Brooklyn 8, N.Y.



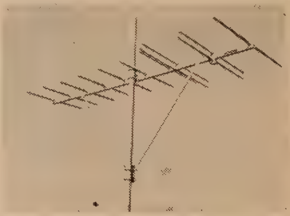
CERAMIC PHONO CARTRIDGES *U-13* and *U-13-2* track at 1 gram or less in low-mass tone arms. Response is flat to RIAA curve, 20 to 20,000 cycles. Compliance, 17×10^{-6} cm per dyne. Channel separation, 25 db average. Turnover design—0.7-mil diamond for long-playing stereo and mono records, 3-mil sapphire for 78's. Socket for direct plug-in into ¼-in. tubular arms; bracket for conventional arms. Weigh 2 grams. *Model U-13* has .001-μf capacitance, 0.3-volt output. *Model U-13-2* is identical except for .005-μf capacitance, 0.15-volt output (for transistor circuits).—**Euphonics Corp.,** Guaynabo, Puerto Rico.

TABLE-MODEL STEREO PHONOGRAPH, *Stereo 360,* uses sealed-sound-chamber principle of monophonic *360* introduced just over a decade ago. Six speakers, all-transistor amplifier with 30 watts total peak output, Garrard changer with Columbia-designed floating tone arm. Ceramic cartridge tracks at 2 grams. Record damage from skipping tone arm claimed virtually impossible. 0.5-mil stylus for stereo records, 1-mil stylus for mono long-playing and other discs. 22 in. wide, 9½ in. high.—**Columbia Records,** 799 7th Ave., New York, N.Y. 10019.

4-TRACK STEREO TAPE RECORDER, the *Criterion 1000* has transistor stereo preamplifiers and push-pull power amplifiers which deliver 6 watts per channel. Frequency responses: 50–15,000 cycles at 7½ ips; 50–10,000 cycles at 3¾ ips; 55–5,000 cycles at 1⅞. All ±3 db. Heavy-duty 4-pole capacitor-start motor keeps wow and flutter to 0.2% at 7½ ips. Separate channel record controls make sound-with-sound recordings possible. Two 6 x 4-in. speakers with adjustable wing panels; 2 dynamic microphones, cables, 7-in. takeup reel; teakwood cabinet. 17¼ x 7¼ x 12¾ in. Stock No. 99-1501-WX.— **Lafayette Radio Electronics Corp.,** 111 Jericho Turnpike, Syosset, N.Y.

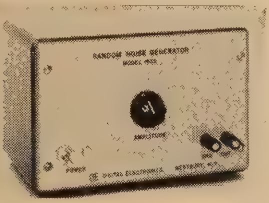


ANTENNA, *model Y-102-130.* 10-element triple-driven Yagi antenna for 120-140 mc. High-strength 606IT6 aluminum alloy construction; elements are heliarc-welded to 1¼-in. square crossarm. Parasitic elements strengthened by reinforcing sleeves crimped over each element/crossarm junction. Braces for protection from wind-load conditions. Characteristics: 11.2-db nominal gain with maximum vswr of 1.5:1 over the 120–140-mc band. Nominal half-power beamwidth in E plane is 50° and 65° in H plane. Maximum power rating 150 watts.—**Taco Defense & Industrial Div.,** Sherburne, N. Y.



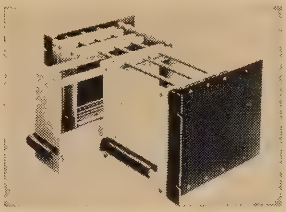
FM STEREO ADAPTER for automobiles can be plugged into the 1965 Chevrolet AM–FM radios with no modification to receiver, using 4 speakers for stereo. 2 front speakers under the instrument panel in cowl kickpads; 2 rear speakers at outboard ends of package shelf behind back seat. Adapter has 11 silicon transistors, 1 germanium power transistor and 6 diodes. Audio amplifier for stereo channel is contained in the unit.– **Delco Radio, Div. of General Motors Corp.,** Kokomo, Ind.

SOLID-STATE TUNER/AMPLIFIER, *model 344.* Tuner has silver-plated 4-nuvistor front end for 2.2-μv sensitivity with 80-db cross-modulation rejection. Limiting circuits make *344* impervious to ignition pulse noises and overloading caused by strong local stations. Stereo multiplex separation is in excess of 35 db. Auto-Sensor provides automatic stereo switching. Compensation network; noise filter; earphone jack; 25 watts music power per channel in 8-ohm load.–**H. H. Scott, Inc.,** Dept. P, 111 Powdermill Rd., Maynard, Mass.



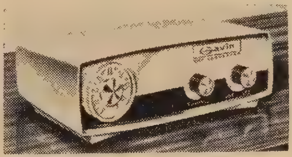
RANDOM-NOISE GENERATOR, *model 1523,* solid-state with output from 10 cycles to 100 kc, output amplitude variable, 10 volts peak and 1 volt rms. Noise spectrum: ±2 db between 10 cycles and 100 kc, and ±1 db between 100 cycles and 100 kc; useful output to 3 mc. Power requirement standard, single-phase, 115 volts, 60 cycles. 8¼ x 5 x 5¾ in.–**Digital Electronics, Inc.** 2200 Shames Dr., Westbury, N. Y.

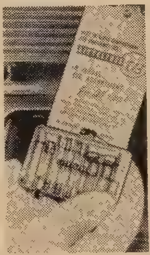
CAPACITOR KIT. *Kit No. 18* provides two pieces each of 14 most popular values of *type VDM,* high-voltage, dipped-mica capacitors especially designed for TV. ±5% tolerance at 1,000 volts dc. Operating temperature range extends to 125°C; engineered with radial leads. Capacitance value, working voltage and tolerance are printed on each unit.–**Arco Electronics, Inc.,** Community Dr., Great Neck, N. Y.



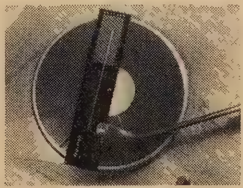
MODULE UNIT (*Vero Module Rack.*) Standard components are made to give 4 module panel widths of 1, 2, 4 and 8 in., and 2 module depths of 7¼ and 10¼ in. Overall width 19 in., heights of 7 or 8¾ in., depths of 11 or 14 in. More than 300 variations possible with this unit.–**Vero Electronics,** 48 Allen Blvd., Farmingdale, N.Y.

UHF-TV CONVERTER LINE. Model shown is *Venus.* Has high-gain built-in amplifier and solid-state circuitry for all-channel reception, including problem areas. Also featured in manufacturer's line are: zone-centered uhf-TV antennas for deep-fringe, near-fringe, suburban and metropolitan areas; uhf boosters and couplers; Citizens-band equipment; electronic transmission lines; color TV yokes; patch cords.–**Gavin Instruments, Inc.,** Dealer Aid Div., Somerville, N. J.





AUTO FUSE-REPLACEMENT KIT combines 10 fuses in hinged plastic case, 2¼ x 1½ x ⅝ in. to protect such equipment as heater, radio, turn signals, backup lights, stop lights, cigarette lighter, air conditioner, windshield wipers, dome lights, instrument lights, etc. For either 6- or 12-volt battery autos, they have these ampere ratings: 1, 2, 3, 5, 7½, 9, 10, 14, 15 and 20.–**Littelfuse, Inc.,** 800 E. Northwest Highway, Des Plaines, Ill.



TRACKING ERROR VISUAL GUIDE, *Tru-Trak,* consists of a pointer assembly that attaches to the cartridge and a calibrated scale that fits over turntable spindle and indicates the tracking variations of tonearm, adjusts tonearm for min-

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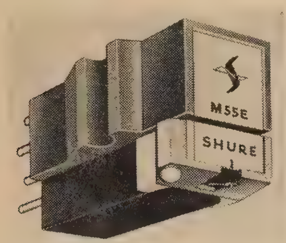
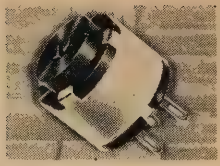
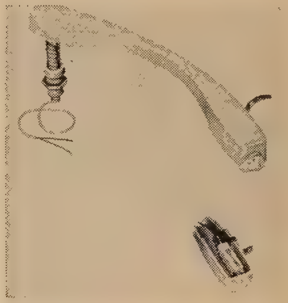
imum distortion, maximum separation for stereo.—**Alard Products**, Somerset, Calif. 95684



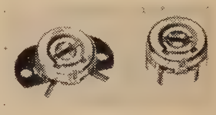
ELLIPTICAL STYLUS CARTRIDGE, *model M55E*. Retractile diamond stylus; tracking angle 15°; response from 20 to 20,000 cycles; output 6 mv per channel at 1,000 cycles at 5 cm/sec; channel separation over 25 db at 1,000 cycles; load impedance 47,000 ohms (per channel); tracking force ¾ to 1½ grams; inductance 680 mh; dc resistance 650 ohms. 4 terminals, standard mounting; weight 7 grams.—**Shure Bros., Inc.**, 222 Hartrey Ave., Evanston, Ill.



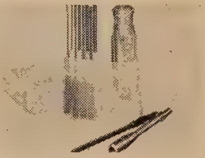
PRINTED-CIRCUIT TRIMMING POTS, *series 63M-1* and *63M-2*, feature overall height of 15/32 in., permitting extremely close board-to-board spacing. 0.25-watt dissipation rating at 70°C; metal-to-metal and carbon-to-carbon contacts. Gold-plated mounting terminals are located for 0.1-in. grid configuration. Mechanical and electrical rotation 295° (±3°). Working voltage 350 ac between end terminals; breakdown voltage 750 ac between terminals and ground. Available in resistance range from 100 ohms to 1 megohm.—**Clarostat Mfg. Co., Inc.**, Dover, N. H.



TONEARMS. *Model T20-T1-S*, with stereo crystal cartridge, output voltage 1.0, or *T20T2-S*, output 2 volts, also with cartridge. *Model T14T-S* has mono crystal cartridge, output 3.6 volts. Both have shielded cable and spring mounting post, are turnover type and play all records, LP, 45 and 78.—**Sonotone Corp.**, Elmsford, N.Y.



BUZZ CONTROLS, 2-watt units, for printed circuit or above-chassis use. Among replacement uses: convergence control in color TV sets; agc, linearity and vertical and horizontal hold in black-and-white TV; bias and sensitivity in auto radios; hum balancing in stereo and hi-fi. Available in 21 values, from 1.5 to 5,000 ohms.—**Centralab, Electronics Div. of Globe-Union Inc.**, Box 591, Milwaukee, Wis. 53201



ALLEN TYPE SCREWDRIVER SET, *PS99-40*, consists of regular-size 4⅛-in. screwdriver handle, 9 interchangeable Allen hex type 4-in. blades with hex sizes from .050 through 3/16 in. and a 4-in. extension shaft. In plastic carrying case which doubles as bench stand.—**Xcelite Inc.**, Orchard Park, N. Y.

SOLDERING GUN, *model 450 "All"*, 5⅝ in. long, has 3 tips providing following range of heat power: fine-point 25–100-watt range; medium-duty 100–200-watt range; heavy-duty 200–450-watt range. Also plastic cutting accessory and flat iron

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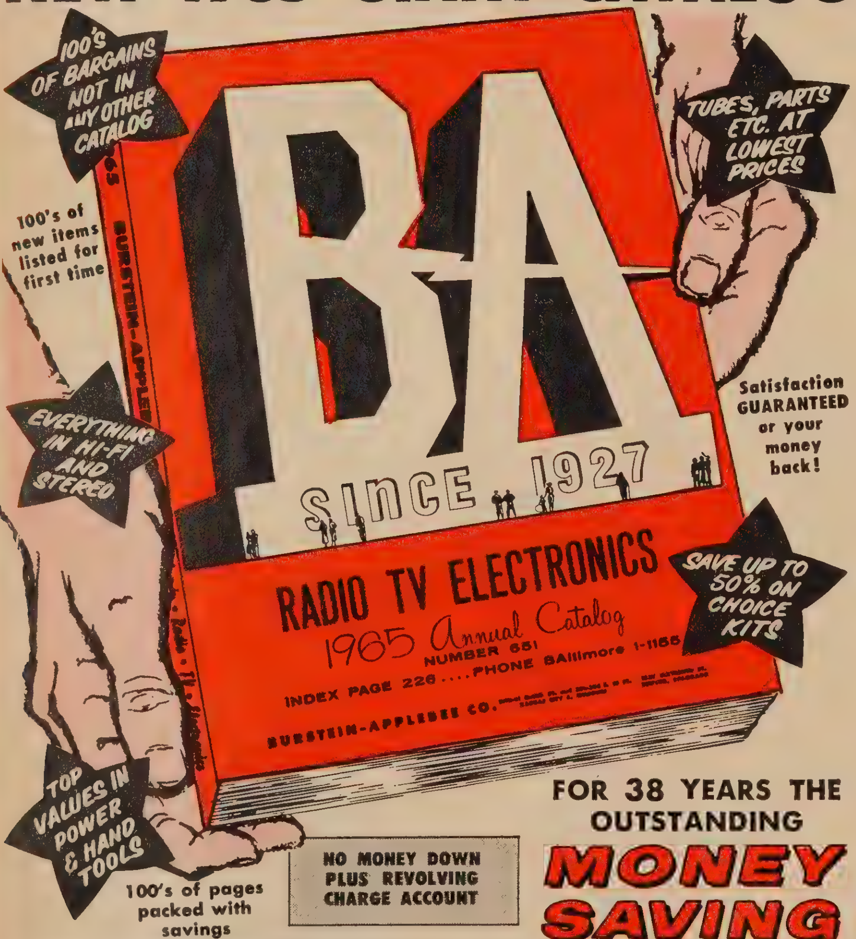
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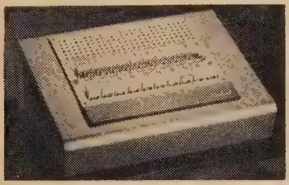
accessory.—**Wen Products, Inc.** 5810 Northwest Highway, Chicago, Ill. 60631

"LIVING LETTERS" has 3-inch reel of 3 lengths of tape—15, 30 and 60 minutes in dust-free mailer with built-in post. Takes 3 x 4½-in. label. Mailbox display unit free with 72-roll order.—**3M Co.,** 2501 Hudson Rd., St. Paul, Minn. 55119

POWER SUPPLY TRANSFORMERS, *TY-86,* are epoxy-molded torodial, work from a 12-volt source and put out 350 dc ma at 425 dc volts. Designed for converting dynamotor supplies in transmitters to solid state power.—**Triad Distributor Div.,** 305 N. Briant St., Huntington, Ind.

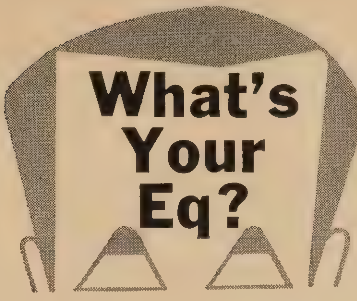


INTERCOM, *7400 series Amplicall,* all-transistor, communicates with up to 18 remote points. On only when in use; talk-listen bar; adjustable volume level; "busy" indicator; central power supply; plug-in junction boxes; acoustically treated enclosures; three types of remote stations and accessory equipment.—**Rauland-Borg Corp.,** 3535 W. Addison St., Chicago, Ill. 60618

MINIATURE ELECTRIC DRILL, *model 9,* accommodates drills up to ⅛-in. diameter and is capable of drilling through ¼-in. solid brass. Starting torque exceeds 5-inch-ounces at 6 volts. Dc-operated from 4 to 12 volts; normal operating current less than 1 amp at 6 volts. Comes with chuck and 3 collets, brush, grinder accessory, 2 polishing wheels, on-off switch.—**Jensen Tools,** 3630 E. Indian School Rd., Phoenix, Ariz. 85018

All specifications from manufacturers data.

Answers to What's Your Eq?



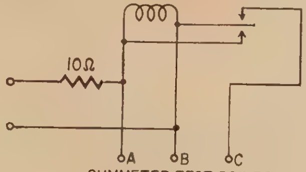
This month's puzzles are on page 48

Noise!

A capacitor's reactance decreases with increasing frequency. The high-frequency noise and harmonics on the power line (almost invisible on the 117-volt input) saw a much smaller reactance than the 60-cycle ac did, and passed pretty much unimpeded. This "amplified" the noise with respect to the ac waveform. It is important that a clean input waveform be always used in this type of circuit, or else the output will be noisy.

Another Black Box

The box contains a running vibrator with B connected to the moving contact while A and C are connected to the



OHMMETER TEST POINTS

stationary contacts. As A—B and C—B are never closed simultaneously, infinite resistance is indicated between A—C. An apparent resistance is indicated between A—B and C—B due to the average time per cycle that the contacts are closed.

The contacts act as an interrupter or chopper which, along with the ohmmeter internal battery, produce a pulsed input to meter. The meter deflects to approximately the same point between half scale and infinity on any ohmmeter range with the exception of the highest, where leakage and the comparatively long time constant of the meter-input circuit become factors.

Input and output

First, where frequency is zero, the capacitive reactances of C1 and C2 become infinite, and the circuit reduces essentially to two resistors with the attenuation factor of (R1 + R2)/R2.

At the opposite extreme, where the frequency approaches infinity, the circuit reduces essentially to two capacitors with the attenuation factor of:

$$\frac{\frac{1}{C1}+\frac{1}{C2}}{\frac{1}{C2}}=\frac{C1+C2}{C1}\,.$$

The circuit will be independent of frequency if and only if the results at the two extremes form the relationship:

$$\frac{C1+C2}{C1}=\frac{R1+R2}{R2}$$

or

$$R2C1+R2C2=R1C1+R2C1.$$

The R1C1 terms appear on both sides of the equals sign and drop out of the equation, so the attenuator meets the requirement if the component values comply with the relationship: R1C1 = R2C2

END

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booklets New Literature charts catalogs

NEW CIRCUIT-SYSTEM BROCHURE, 24 pages with photos and specs on 80 Vero circuit boards and accessories showing how to "write" a schematic on these universal wiring boards and use them unchanged in production.—**Vero Electronics, Inc.**, 48 Allen Blvd., Farmingdale, N.Y.

TEST EQUIPMENT BULLETIN, *No. 2066,* 16 pages of specs and prices on line of test equipment including Model 260 volt-ohm-milliammeters, vom adapters, vacuum-tube volt-ohmmeters, hand-sized testers, portable standards, temperature measuring equipment, scopes and accessories.—**Simpson Electric Co.**, 5200 W. Kinzie St., Chicago, Ill. 60644

TECHNICAL PAPERS, *TP-46,* "A Ceramic Band Pass Transfilter and Filter Element", and *TP-47,* "An Introduction to Clevite Piezoelectric Ceramic Filters", 26 and 28 pages with drawings. —**Piezoelectric Div. of Clevite Corp.**, 232 Forbes Rd., Bedford, Ohio

MICROWAVE TUBES & COMPONENTS CATALOG, 10 pages, looseleaf punched, listings and specs of line of microwave triodes, traveling wave tubes, high-power uhf klystrons, millimeter klystrons (up to 150 Gc), magnetrons, and range of matching components. Write on company letterhead.—**Amperex Electronic Corp.,** Advertising Dept., Hicksville, N.Y. 11802.

PICTORIAL REVIEW OF MODULAR SUBSYSTEMS, *No. 9343,* 10 pages, looseleaf punched, explains such examples as motor speed controls, signal amplifiers, reference amplifiers, a hydrogen thyratron replacement, etc.—**Technical Information Center, Motorola Semiconductor Products, Inc.**, Phoenix, Ariz. 85001

OUTLET BOXES CATALOG, *No. 564,* 8 pages with photos and specs on 123 varieties of master power controls including new line of 4-ft heavy-duty outlet boxes.—**Waber Electronics, Inc.**, Hancock & Somerset Sts., Philadelphia, Pa. 19133

MINIATURE SWITCH FOLDER, *No. 265.* Photos and specs on assortments of toggle switches, rotary switches (with or without knob), switch plate kit and ceramic solder-strip kit.—**Alcoswitch,** Lawrence, Mass.

COMPONENTS CATALOG, *No. 100,* 36 pages. Photos and specs of cartridges, mikes, arms, earphones, cabinets, speakers, baffles, subminiature electrolytic kits, i.f. transformer kits, volume-control kits, capacitors, tuners, jacks, tape recorder and deck, guitar and amplifier—**Speco Components Specialties, Inc.,** 101 Buffalo Ave., Freeport, N.Y.

MEASURING INSTRUMENTS FACT SHEET, Section 2900 EEM file system, gives frequency range, dial accuracy, response, distortion, price and dimensions of oscillators (½ cycle to 1.5 mc), voltmeters (10 cycles to 4 mc), and transmission measuring sets (10 cycles to 1 mc). —**Waveforms, Inc.,** 333 6th Ave., New York, N.Y. 10014

DELAY-RELAY CATALOG, on CD series of solid-state time-delay relays. 12 pages, looseleaf punched, photos, specs, diagrams for wiring, dimensions and table of 250 variations of time-delay relays.—**Potter & Brumfield,** Princeton, Ind.

TWO-WAY RADIO CATALOG, *No. 12,* 80 pages with photos, drawings and specs. Includes omnidirectional, bidirectional and unidirectional antennas in frequency bands from 27 to 470 mc as well as duplexers, cavity filters, coaxial cable assemblies and mounting hardware. Engineering section and price list.—**Decibel Products, Inc.,** 3184 Quebec St., Dallas, Tex. 75247

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears.

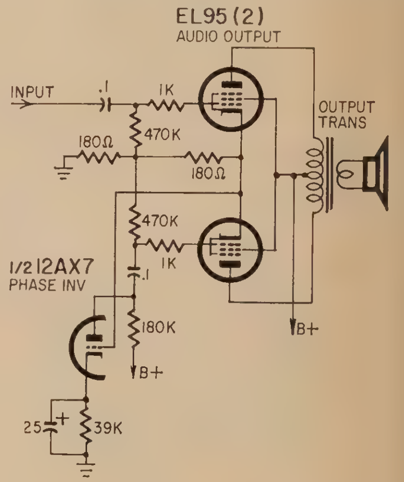
UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

noteworthy Circuits

NOVEL PHASE INVERTER

In the popular floating paraphase circuit, the phase inverter gets its grid signal from across a resistor connected between ground and the junction of the grid resistors in the push-pull stage. An article in *Populaer Radio og Fjernsyn* (Copenhagen, Denmark) shows the same circuit with a new twist.

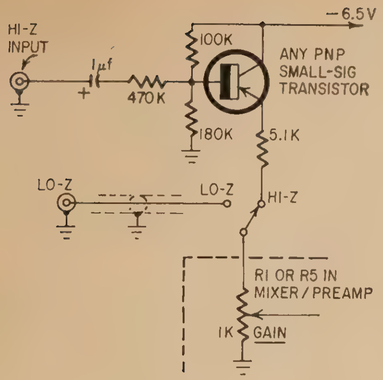
In this circuit, the upper output stage is driven by a voltage amplifier (not shown), and an in-phase signal is developed across the common cathode resistors. This voltage is tapped off and fed to the phase-inverter grid. This signal is amplified, shifted 180° and fed to the grid of the lower output stage. The added gain provided by the phase-inverter tube is partially cancelled by cathode voltages of opposite polarity that are developed in the lower half of the push-pull stage. With the resistor values shown, the signals on the output grids are very nearly balanced.



HIGH-IMPEDANCE INPUT FOR MIXER/PREAMP

The "Multi-purpose 2-Channel Mixer/Preamp" (March 1963) was designed for mike and line inputs of 600 ohms or lower. Mr. Schotz recommended using a matching transformer with high-impedance signal sources.

This emitter-follower circuit replaces the matching transformers while providing better frequency response. I designed it for mixing two crystal or ceramic mikes. No transistor is speci-



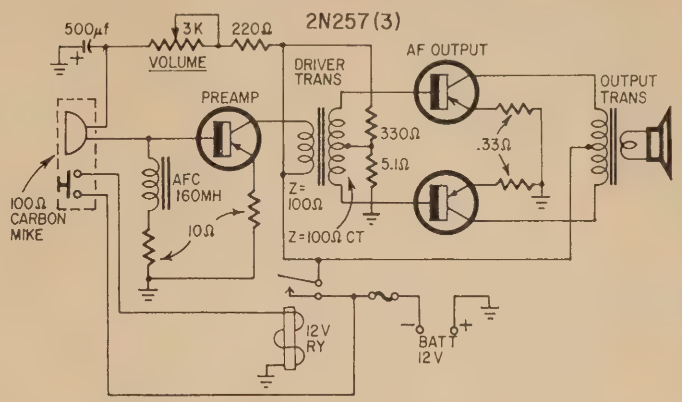
fied. You can use almost any small-signal p-n-p germanium or silicon transistor.

I use one emitter follower ahead of each input channel. With a pair of selector switches connected as shown, the preamp/mixer handles two high-impedance sources, two low-impedance sources or one high- and one low-impedance source.

I want to thank Messrs W. Seward and R. O. Parker for helping me design this circuit.—*Leonard H. Zandel*

POWER MEGAPHONE

Class-A operation is normally used in transistor preamps to insure minimum distortion. This requires that the quiescent collector current must be high to prevent clipping at high input levels. Thus, there is a waste of battery power at low signal levels. When a carbon mike is used, a transformer is generally used to isolate the mike and input currents and to match impedances.



Here is a microphone amplifier, covered by patent No. 3,132,207, that eliminates the input transformer and features a special circuit that controls the input collector current according to input signal level so as to minimize battery drain. This circuit was designed for power megaphones, portable PA and modulators in mobile transmitters.

The microphone is a 100-ohm carbon type that includes a push-to-talk button. The carbon element is in series with a part of the base biasing network. When the volume control is set for low volume, a large portion of its resistance is in the circuit, thus simultaneously decreasing the dc voltage fed to the microphone and the ac signal fed to the transistor. Since the mike button is in the bias network, it also reduces the base bias. When the volume control is set for full output (zero resistance), the mike voltage is increased and the base bias is raised to minimize clipping.

The audio choke provides the high impedance needed to develop the maximum audio signal between base and ground. The emitter resistor may be bypassed to reduce negative feedback.

The transistors in the prototype are 2N257's. Equivalents such as 2N255's may be used. The output transformer should match the transistors and speaker. END

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technicians' News

ANTI-PAY-TV SENTIMENT: NEA RESOLUTION AND RALEIGH PETITION

The National Electronics Association at its convention in Detroit on Sept. 20 issued a resolution against cable antenna television systems and pay-television plans "in any community where television signals are available to the general public in sufficient strength and variety to fulfill their requirements."

NEA also determined, in the same resolution, to "actively seek to secure FCC regulation of CATV operations." It went on record as holding the opinion that CATV seems to be leading "toward captivating the viewing audience, the TV service business, the TV antenna maintenance business, and even, possibly, the sale of TV receivers".

In a separate action, the Raleigh, N. C., committee for free TV has filed a petition with city officials for a referendum on a recently granted cable television (CATV) franchise.

The petition, signed by more than 4,500 citizens, seeks to block further moves to install CATV in Raleigh.

The Raleigh area is now served by TV stations WTVD in Durham and WRAL in Raleigh.

The Raleigh City Council gave preliminary approval to an ordinance on July 31 which would permit CATV. The ordinance simply sets a $20 maximum installation fee and a $6 maximum monthly subscribers' fee. The service would be rendered by a new company, the Southeastern Cablevision Co., formed from a merger of the Raleigh TV station and the Raleigh Cablevision Co.

NATESA SOLE REPRESENTATIVE FOR U.S. LABOR DEPT. PROJECTS

The National Alliance of Television & Electronic Service Associations has been made the sole representative for the U.S. Labor Department's "on-the-job" apprenticeship projects.

A 12-month, $31,254 contract was signed late in September at the U.S. Court House in Chicago. Under the plan, NATESA will establish a field representative whose function will be to travel across the nation establishing programs in various cities.

Signing for the U.S. Labor Department was acting regional director Orvis Wertz, and, for NATESA, executive director Frank J. Moch. The contract was the latest step in a project that began 8 years ago.

All NATESA affiliates are urged to participate in the program. At this writing, the field man has not yet been named, but he is expected to contact each affiliate that expresses interest. Requests will be filled in order of receipt as nearly as possible.

Nonaffiliated locals, and areas without locals, that are interested in the plan should contact NATESA, 5908 S. Troy St., Chicago 29, Ill.

According to a note in *TESA News*, the official publication of the TV-Electronic Service Association of St. Louis, Mo., the group recently began its own apprenticeship training program. The program is part of the overall U.S. Labor Department–NATESA plan.

TV SERVICE GETS FREQUENT PUBLIC COMPLAINTS

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complaint against the television industry is about service, dealers at the National Appliance & Radio-TV Dealers Association School of Service Management were told. The remark was in a speech by Carl A. Dalke, president of the Metropolitan Chicago Better Business Bureau.

He contended that the problem arises from a lack of confidence in service technicians, or a lack of communication between customers and technicians. Courtesy is also a factor, Mr. Dalke said.

A New York dealer, during a bull session after the talk, questioned the honesty of a large New York City department store's claim in newspaper ads that it has its own service department, when actually it has only a "token" staff, and most service work is really done by an independent company.

SURVEY OF TV SERVICE INDUSTRY PLANNED

Interested manufacturers and distributors who work with and through the home-entertainment products' service industry will be asked soon to assist in a comprehensive survey of the service industry, aimed at learning of its problems and of possible solutions for them.

Dave Krantz, service manager of Sunshine Scientific Instruments Co., Philadelphia, and long a prime mover in service organizations, stated that the Pennsylvania Federation of Radio, TV and Electronics Service Associations has approved a plan to ask manufacturers' assistance.

New York groups have also been approached, and others are expected to be asked to join.

Under the plan, manufacturers will be asked to help organize and finance a questionnaire to gather as much information as possible about service people.

"The combination of better manufacturing processes and facilities, longer warranties and the growing use of . . . solid-state devices means less service problems and less work for the individual servicemen and shops," said Mr. Krantz.

"The trend to more and more economical transistor radios and to smaller, cheaper and transistorized TV sets means that it is possible that people will not have service performed on much of this merchandise—that it is better to replace the units."

Krantz also mentioned ignorance of solid-state circuitry as a serious problem among servicers, and that there is a predominance of "mom and pop" stores that find it difficult to organize into larger, really effective groups.

"The manufacturers spend a great deal of promotional money on their products and some of this money could go to getting the service industry on its feet."

Other problems worth attention, according to Krantz, are the average age of service technicians—over 40, and bit old to retrain, and the scarcity o young technicians.

"NEW BREED" OF TECHNICIAN COMING?

A "new breed" of television technician is evolving—a more "professional" type than his predecessors. This i the opinion of Albert C. W. Saunders director of the Saunders Radio & Electronic School, Inc. He announced it in talk at the quarterly meeting of th Electronic Industries Association's Service Committee in Boston late in September, and expanded his views in an interview with *Home Furnishings Daily*.

In his talk, Mr. Saunders traced the changes in servicing techniques and procedures through the years. He said the trend is to certified engineering technicians. The consumer-level servicer will be better educated and trained because his work will now involve "1 mental operations to one manual."

Uhf will be a principal influence in this change, said Mr. Saunders. The higher-level service technician will command a higher salary, he added.

Among other business at the EIA Service Committee meeting, a subcommittee was appointed to study schematic symbols as used by various manufacturers to see how they might be made more understandable. END

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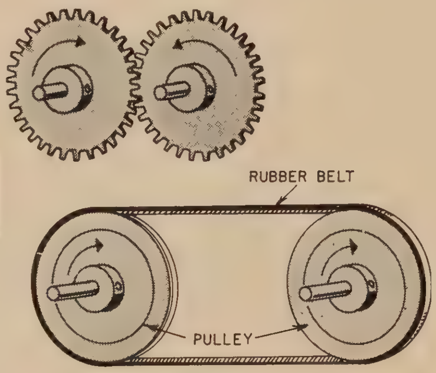
GEARS OR BELT DRIVES MAKE EXPERIMENTAL GANGED POTS

Before I go to the expense of buying dual ganged potentiometers for an experimental circuit, I use a temporary drive made up of gears or pulleys and a belt.

The gears are fine-tooth 1½-inchers robbed from a piece of surplus equipment. Many junk, hardware and surplus-electronics outlets carry either gears or equipment containing gears.



I also keep a pair of drive wheels from discarded TV tuners, 1¾ inches in diameter, and several Walsco rubber drive belts. The gear system drives the two pots in opposite directions, which is all right for linear pots or for getting a log–reverse-log pair. To run the pots in the same direction, either put a third gear between the two, as an idler, or use the belt-and-pulley drive.—*Tom Jaski*

RENEWING WRINKLE FINISHES

Wrinkle and crackle finishes for electronic equipment have been popular for many years because of their resistance to scratching and abrasion. But even with the best of care, the appearance of the wrinkle finish after years of hard use leaves much to be desired. The following tip, picked up from Western Union maintenance people, has proved very helpful.

Grocery and janitors' supply outlets carry a cleaning compound known as "Soil-Off". This mild but highly effective cleaning agent is a water-thin liquid prepared by Economics Laboratory, Inc., St. Paul, Minn. Simply apply the cleaner, full strength, with a damp cloth. If the cloth becomes very dirty, rinse it in water and continue the application until the imbedded dirt is removed. After the surface is dry, an application of liquid wax, buffed with a shoe brush, will restore the finish.

In some cases, the finish may be marred or stained to the extent that cleaning isn't enough. There is another method, short of complete refinishing, that works wonders. Thin down some gloss enamel, of the same color as the original finish, with turpentine or other solvent, to a waterlike consistency. Apply it with a cloth. Thoroughly saturate the wrinkle-finished surface but avoid runs and drips. Allow it to dry, and apply as many more coats as necessary to get the finish you want.

Besides keeping your equipment "pretty" for your own satisfaction, these pointers can mean dollars in your pocket when you sell or trade.—*Roy E. Pafenberg*

BATTERY ECONOMY

Radio-control experimenters and many other electronic hobbyists have dozens of batteries. Very often they are forced to throw some out or risk a fly-away because their future life is unpredictable. Tests, even under load, are rarely true indicators of how a battery will behave after another ½ hour of use. It is usually safer to use new ones.

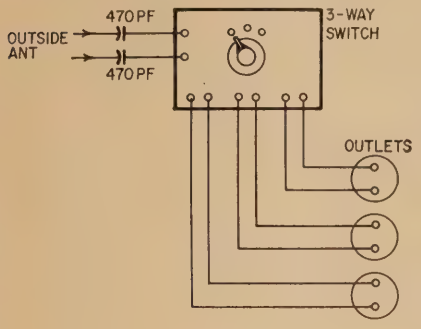
A simple accounting system can often save many dollars' worth of batteries a year. Whenever you buy new batteries, number each one with a china marking pencil or felt-tip marker and write corresponding numbers in a notebook. Mark down in your notebook each period of use of each battery and the type of use. (Example: receiver filaments—1 hour.) Then you'll always know whether it's safe to use a battery for another day of flying or cruising.

A sound judgment about the future life of the battery can be made on the basis of both the tester reading and the record of past use. In addition, you'll never get new batteries mixed up with old ones and you'll never have to throw out batteries until they've given their all. Often, batteries too weak for use in one position, such as powering servos, are adequate for, say, powering running lights.—*Ronald S. Newbower*

CAPACITORS PROTECT COILS

Since most portable and some console TV receivers are transformerless, the antennas are protected so the antenna coils will not be burned out by a grounded antenna.

On portables especially, when the back is removed and the antenna wires



unplugged, the isolation capacitors are left on the back cover, leaving the antenna coils unprotected.

We inserted two 470-pf capacitors in series with the antenna lead coming to the three-way antenna switch on the shop workbench. Now we never have to worry about burning out antenna coils on customers' sets.—*Homer Davidson*

"LIQUID GROMMETS" SOLVE CHAFING PROBLEMS

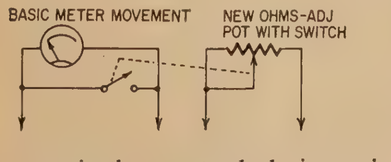
When wires have to run through openings in chassis where rubber grommets can't be installed to prevent chafing the insulation, make a permanent grommet by coating the wire with automobile type permanent gasket cement (Permatex) next to the hole. Pull the wire back and forth through the hole for a distance of a couple of inches, then let the cement set, to make an excellent and long-lasting grommet.—*H. Josephs*

SWITCH PROTECTS VOLT-OHMMETER

If you find that inexperienced people damage your vom, protect it by replacing the ohms-adjust pot with another pot of the same value but with an spst switch attached.

Cut one of leads to the basic meter movement and wire in the switch. This way, when you're through using the meter, you can turn the ohms-adjust control counterclockwise until it clicks and be sure your meter is safe from damage.—*Allan Glaser*

[If a double-throw switch—obtainable from Centralab, Mallory, and others—is used, do not cut the meter lead. Instead, connect the switch to short



the meter in the counterclockwise position (see diagram). This damps the meter and protects it against rough handling when it is not in use.—*Editor*]

QUICK CHECK FOR TOTAL CURRENT DRAIN

I have found that I can measure the total current drain of a receiver (especially a transistor receiver) by turning the set off and connecting an ammeter across the switch terminals. A 10- or 20-ma meter will do for most transistor portables. A 500-ma ac meter will take care of most table radios.—*Julian Jorstad*

END

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1A3	.73
1A5	.73
1A6	.73
1A7	1.30
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1AE4	1.34
1AF4	1.30
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2FS5	1.47
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2X2	.60
2X2A	1.30
3A2	1.20
3A3	.74
3A4	.58
3A5	1.10
3AF4	.99
3AL5	.44
3AT2	.71
3AU6	.52
3AV6	.40
3AW3	.72
3B2	3.45
3B7	1.35
3BA6	.49
3BC5	.61
3BE6	.54
3BN4	.76
3BN6	.73
3BU8	.76
3BY6	.56
3BZ6	.54
3CB6	.54
3CE5	.56
3CS6	.56
3CF6	.62
3CY5	.69

Tube	Price
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3DG4	.83
3DK6	.58
3DT6	.52
3DZ4	.79
3EH7	.60
3EJ7	.60
3ER5	.86
3FH5	.63
3FS5	.74
3GK5	.59
3GW5	.53
3HA5	.99
3HK5	.59
3HS8	1.29
3Q4	.61
3Q5	2.00
3S4	.73
3V4	.61
4AU6	.52
4AV6	.40
4BA6	.85
4BC5	.56
4BC8	1.00
4BL8	.61
4BN6	.72
4BQ7	.99
4BS8	.96
4BU8	.71
4BZ6	.56
4BZ7	1.00
4CB6	.55
4CS6	.59
4CY5	.70
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4EW6	.56
4GK5	.59
4GM6	.58
4GS8	1.29
4GZ5	1.49
4GZ6	.59
4HC7	.73
4HM6	.56
4HS8	.71
4HT6	.99
4JC6	1.64
4JD6	1.64
5AM8	.77
5AN8	.88
5AQ5	.52
5AR4	1.40
5AS8	1.75
5AT8	.81
5AV8	.98
5AZ4	.73
5B8	1.30
5BC3	1.31
5BE8	.81
5BK7	.84
5BQ7	.99
5BR8	.81
5BT8	.79
5BW8	1.31
5CG8	.79
5CL8	.74
5CM8	.88
5CQ8	.82
5CZ5	.70
5DE8	.81
5DJ4	.77
5EA8	.78
5ES8	1.11
5EU8	.78
5EW6	.56
5FG7	.67
5FV8	.77
5GH8	.62
5GM6	1.04
5GX6	.54
5HC7	1.49
5HG8	.80
5J6	.70
5KE8	1.24
5T4	.84
5T8	.84
5U4	.58
5U8	.82
5V3	.88
5V4	1.45
5V6	.54
5W4	1.75
5X4	.90
5X8	.80
5Y3	.44
5Y4	.64
5Z3	1.50
5Z4	1.75
6A3	2.75
6A4	.78
6A5	3.00
6A6	1.95
6A7	1.10
6A8GT	1.10
6A8M	1.15
6AB4	.44
6AB5	3.00
6AB7	1.00
6AC5	1.95
6AC7	.93
6AD7	3.25
6AE5	2.50
6AF3	.71
6AF4	.99
6AF4A	.99
6AF6	2.50

Tube	Price
6AF11	1.98
6AG5	.68
6AG7	1.35
6AH4	.79
6AH6	1.05
6AJ5	1.95
6AJ8	1.73
6AK5	.90
6AK6	.80
6AL5	.35
6AL7	2.10
6AL11	1.05
6AM8	.76
6AN4	1.59
6AN5	2.65
6AN6	2.45
6AN8	.91
6AQ5	.52
6AQ6	1.00
6AQ7	1.73
6AQ8	.77
6AR5	.53
6AR6	.87
6AR8	2.00
6AR11	1.70
6AS5	.59
6AS6	.78
6AS7	2.75
6AS8	.83
6AS11	1.98
6AT6	.47
6AT8	.84
6AU4	.83
6AU5	.50
6AU6	.50
6AU7	.70
6AU8	.85
6AV5	.89
6AV6	.39
6AV11	1.65
6AW8	.88
6AX3	.93
6AX4	.64
6AX5	.73
6AX7	.62
6AX8	1.45
6AY3	1.15
6AZ8	1.30
6B4	3.80
6B5	4.00
6B7	2.00
6B8	2.00
6B10	1.39
6BA3	1.15
6BA6	.48
6BA7	.98
6BA8	.88
6BA11	1.22
6BC4	2.10
6BC5	.59
6BC7	.88
6BC8	1.00
6BD5	1.20
6BD6	.55
6BE3	.71
6BE6	.53
6BF5	.88
6BF6	.42
6BF8	1.70
6BG6	1.65
6BH6	.66
6BH8	.94
6BJ6	.63
6BJ7	.77
6BJ8	1.45
6BK4	1.75
6BK5	.91
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6CA7	1.35
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6CB6	.53
6CD6	1.47
6CF6	.95
6CG7	.59
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6CK4	.69
6CL6	.92
6CL8	.77
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6CM7	.67
6CM8	1.02
6CN7	.68
6CO4	1.35

Tube	Price
6CQ7	1.80
6CQ8	.90
6CR6	.58
6CS6	.55
6CS7	.67
6CU5	.56
6CU6	1.05
6CU8	.99
6CW4	1.90
6CW5	.78
6CX8	1.82
6CY5	.68
6CY7	.69
6CZ5	1.80
6CZ7	1.95
6D4	1.75
6D6	.67
6D10	1.95
6DA4	.66
6DA5	1.28
6DB5	.67
6DC6	1.30
6DC8	1.33
6DE4	.68
6DE6	.59
6DE7	.73
6DG6	.60
6DJ8	1.17
6DK6	.57
6DN6	1.76
6DN7	1.35
6DQ5	1.89
6DQ6	1.05
6DR7	.73
6DS4	1.40
6DS5	1.30
6DT5	.79
6DT6	.51
6DT8	.92
6DV4	2.65
6DW4	.90
6DW5	.99
6DZ4	.78
6E5	2.25
6EA7	.88
6EA8	.77
6EB5	.71
6EB8	.91
6EH5	1.33
6EH7	.59
6EH8	.77
6EJ7	.77
6EM5	.75
6EM7	.80
6EQ7	.70
6ER5	.88
6ES5	.68
6ES8	1.39
6ET7	1.04
6EU7	.66
6EU8	.77
6EV5	.73
6EW6	.55
6EW7	.78
6EY6	.73
6EX6	3.65
6EZ5	.88
6EZ8	.93
6FA7	1.32
6FD7	2.37
6FJ7	1.79
6F4	2.35
6F5GT	1.10
6F5M	1.50
6F6	1.50
6F6M	1.25
6F7	2.50
6F8	1.25
6FG5	2.15
6FG7	.67
6FG8	.65
6FH5	.73
6FJ5	2.25
6FM7	.77
6FQ7	.56
6FS5	.74
6FV6	.68
6FV8	.77
6FW5	1.96
6FW8	4.25
6FY5	1.25
6G5	1.23
6G6G	1.00
6G11	2.10
6GE5	.92
6GE7	.77
6GF5	1.75
6GH8	.78
6GJ5	1.12
6GK5	.59
6GK6	.77
6GL7	2.35
6GM5	.78
6GM6	.58
6GN8	.92
6GQ7	1.89
6GR7	.78
6GT5	1.00
6GV5	.98
6GV6	1.85
6GW6	1.00
6GW8	1.50
6GX6	.55
6GX8	1.25
6GY5	.53
6GY6	1.10
6GZ5	.53
6HA5	.99
6HB5	2.09
6HF5	1.90
6HF8	1.25

Tube	Price
6HG8	.79
6HJ8	.80
6HK5	.59
6HL8	.71
6HS8	.79
6HZ6	.56
6H6	.56
6J4	2.95
6JB6	.98
6JC8	.74
6JE6	2.00
6JE8	1.50
6J5M	.92
6J6	.69
6J7	1.65
6J8	1.40
6J11	1.83
6JH6	.55
6JH8	1.85
6JK8	.68
6JT8	1.75
6JV8	.68
6JZ8	.83
6K6	.61
6K7	.95
6K7G	.75
6K8GT	.87
6K8M	1.85
6K11	1.50
6KD8	1.12
6KT8	.80
6KU8	1.05
6KZ8	.67
6LB8	1.00
6L5	.90
6L6G	.98
6L6GA	1.40
6L6GB	1.50
6L6GC	1.65
6L6M	2.50
6L7	1.05
6M11	1.85
6N6	1.45
6N7	.96
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6Q7GT	1.27
6Q7-M	1.45
6Q11	1.05
6R7	1.25
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6SA7GT	.97
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6SB7Y	1.15
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6SK7M	1.46
6SLGT	.81
6SN7	.63
6SQ7	.92
6SR7	1.00
6SS7	.95
6SZ7	.95
6T4	.96
6T8	.83
6U5	1.75
6U8	.81
6V3	1.10
6V4	.59
6V6GT	.52
6V6M	2.50
6W4	.60
6W6	.69
6X4	.39
6X5	.51
6X8	.78
6Y6	1.00
7A4	.87
7A5	.87
7A6	1.15
7A7	.87
7A8	.66
7AD7	1.15
7AF7	1.45
7AG7	.87
7AH7	1.25
7AU7	.63
7B4	1.45
7B5	.87
7B6	.87
7B7	.87
7B8	1.25
7C4	.69
7C5	1.35
7C6	.87
7C7	.89
7E5	.87
7E6	1.15
7E7	1.25
7EY6	.73
7F7	1.75
7F8	.88
7G7	1.25
7H7	1.35
7HG8	1.67
7J7	1.95
7K7	1.95
7L7	1.95
7N7	1.95
7Q7	.87
7R7	.87
7S7	.87
7V7	1.85

Tube	Price
7W7	1.85
7X6	1.25
7X7	1.85
7Y4	.67
7Y7	1.25
7Z4	.87
8AU8	.88
8AW8	.91
8BH8	.87
8BQ5	.61
8CG7	.61
8CM7	.69
8CN7	.95
8CS7	.72
8CX8	.89
8EB8	.92
8EM5	1.15
8ET7	1.08
8FQ7	.54
8GN8	.97
8JV8	.93
8KA8	.84
9A8	.98
9AU7	.67
9BR7	1.32
9CL8	.77
9EA8	.66
9U8	.80
10AL11	1.09
10BQ5	.89
10C8	1.03
10DE7	.73
10EG7	.86
10EM7	1.75
10EW7	.97
10GN8	.93
10HT8	1.12
10JA8	.92
10KU8	1.07
10Y	.73
11CY7	.73
11JE8	1.70
11KV8	1.52
12A4	.59
12A5	.95
12A6	.85
12A7	1.45
12A8	3.00
12A11	1.74
12AB5	.58
12AC6	.53
12AD6	.55
12AE6	.48
12AE7	.92
12AF3	.71
12AF6	.65
12AG6	.60
12AJ6	.60
12AL5	.45
12AL8	.93
12AL11	1.06
12AQ5	.58
12AT6	.48
12AT7	.74
12AU6	.49
12AU7	.59
12AV5	.93
12AV6	.39
12AV7	.80
12AW6	.98
12AX3	.63
12AX4	.65
12AX6	.62
12AX7	.61
12AY7	1.42
12AZ7	.84
12B4	.66
12BA6	.49
12BA7	.82
12BD6	.48
12BE3	.67
12BE6	.51
12BF6	.58
12BH7	.75
12BK5	.98
12BL6	.54
12BN6	.97
12BQ6/ CU6	1.11
12BR7	.72
12BV7	.74
12BW4	1.09
12BY7	.75
12BZ6	.75
12BZ7	.84
12C5	.56
12CA5	.60
12CN5	.54
12CR6	.65
12CS6	.63
12CT8	1.60
12CU6/ BQ6	1.05
12CX6	.52
12D4	.67
12DB5	.67
12DE5	.60
12DE8	.81
12DL8	.85
12DQ6	1.02
12DQ7	1.33
12DS7	.82
12DT5	.74
12DT7	.77
12DT8	.76
12DW7	1.20
12DY8	1.75
12DW8	.87
12DZ6	.60
12EA6	.99

Tube	Price
12EC8	1.38
12ED5	.60
12EG6	.60
12EK6	.60
12EL6	.48
12EL8	.86
12EZ6	.55
12F5	1.50
12F8	.64
12FA6	.77
12FK6	.48
12FM6	.48
12FQ8	.78
12FR8	.95
12FX5	.64
12FX8	.88
12GA6	.63
12GC6	1.04
12GE5	.93
12GW6	1.02
12J5	.95
12J8	.82
12K5	.73
12K8G	.87
12K8	3.00
12L6	.71
12L8	.50
12Q7	1.35
12Q7M	2.50
12R5	.75
12SA7	.87
12SA7GT	1.25
12SA7M	2.50
12SC7	.78
12SF5GT	.98
12SF5M	1.75
12SF7	.98
12SF7GT	.57
12SF7M	1.75
12SG7	.95
12SG7M	1.10
12SH7	1.39
12SJ7	.99
12SJ7M	1.75
12SK7GT	.93
12SK7M	1.25
12SL7	.78
12SN7	.65
12SQ7GT	.89
12SR7	.98
12U7	.60
12V6	.62
12W6	.69
12X4	.45
13DE7	.73
13DR7	.72
13EM7	1.95
13FD7	.84
13FM7	.78
13GF7	.78
14A4	1.25
14A5	1.10
14A7	.87
14AF7	1.35
14B6	.87
14B8	1.75
14C5	1.50
14C7	1.75
14E6	1.25
14E7	1.25
14F7	.87
14F8	1.75
14GT8	.80
14H7	1.60
14J7	1.45
14N7	1.25
14Q7	.87
14R7	.87
14S7	1.65
14W7	1.25
14X7	1.25
14Y4	1.25
15AF11	1.95
15CW5	1.15
15FY7	1.29
15HB6	1.28
15KY8	.83
16AQ3	1.42
16GK6	.57
17AX3	.51
17AX4	.65
17AY3	.68
17BE3	.57
17BQ6	1.10
17BS3	.86
17C5	.56
17C9	1.18
17D4	.67
17DE4	1.29
17DM4	.78
17DQ6	1.04
17DQ7	1.85
17GE5	1.70
17GJ5	.99
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17HC8	1.18
17JB6	1.12
17JZ8	.93
17L6	.56
17LD8	1.20
17W6	.68
18A5	.99
18FW6	.47
18FX6	.51
18FY6	.84
19	.75
19AU4	.85
19BG6	1.35

Tube	Price
19C8	1.05
19CL8	.57
19EA8	.77
19GQ7	1.99
19HV8	1.44
19JN8	1.20
19Q9	.75
19T8	.83
2050	1.05
21EX6	1.47
21GY5	1.02
22BH3	.74
22BW3	1.43
22DE4	.67
22JG6	1.06
25A7	3.00
25AC5	2.00
25AK4	.66
25AV5	1.00
25AX4	.68
25BK5	.89
25BQ6	1.12
25B8	1.73
25C5	.51
25CA5	1.85
25CD6	1.50
25DK4	1.05
25DN6	1.50
25EH5	.53
25F5	.56
25L6	.55
25W4	.66
25Z5	1.10
25Z6	.73
27GB5	1.59
32ET5	.53
32L7	.85
33GY7	1.40
34DG5	.51
34GD5	.79
35A5	.85
35B5	.95
35C5	.49
35EH5	.55
35L6	.58
35W4	.40
35Y4	1.63
35Z3	1.20
35Z5	.58
50A1	3.95
50A5	1.49
50B5	.68
50C5	.51
50DC4	.46
50EH5	.95
50HC6	.86
50HK6	.54
50L6	.59
50X6	.67
50Y6	.95
50Y7	1.10
60FX5	.60
70L7	.89
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117P7	3.95
117Z3	.83
22	.95
24A	.95
26	1.10
27	1.50
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30	1.15
32	1.00
33	.85
34	.79
35-51	.85
36	.95
37	.70
38	.90
39/44	.85
41	.95
42	1.25
43	1.20
45	2.00
46	.95
47	2.10
48	3.50
50	1.45
53	2.98
55	1.90
56	.95
57	1.35
58	1.85
59	2.50
71A	.95
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76	1.40
77	1.25
78	1.15
80	1.25
81	1.25
82	1.23
83	2.10
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6AT6 6AT8 6AU4 6AU5 6AU6 6AV6 6AW8 6AX4 6BA6 6BC5 6BD6 6BG6 6BH6 6BJ6 6BL7 6BN4 6BN6 6BQ6 6BZ6 6C4 6C6 6CB6

6CD6 6CF6 6CG7 6CG8 6CM7 6CZ5 6D6 6DA4 6DE6 6DQ6

6EM5 6F6 6H6 6J5 6J6 6K6 6K7 6Q7 6S4 6SA7

6SC7 6SH7 6SJ7 6SK7 6SL7 6SN7 6SQ7 6SR7 6U7 6U8

6V6 6W4 6W6 6X4 6X5 7A7 7A8 7B6 7B7 7B8 7C5 7N7 7Y4 12AD6 12AE6 12AF6 12AT7 12AU7 12AX7 12BA6 12BD6 12BE6 12BF6

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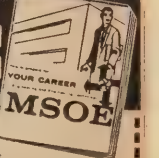

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12	.40	.60	.70	.85
18*	.25	.45	.60	.85
35	.85	1.10	1.40	1.60
100	1.75	2.15	2.50	3.10
240	4.50	5.70	6.90	8.40

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3	.40	.45	.50	.60
12	1.00	1.25	1.40	1.55
18*	1.00	1.30	Query	Query
35	2.25	2.50	2.85	3.40
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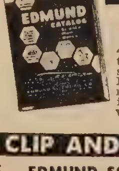

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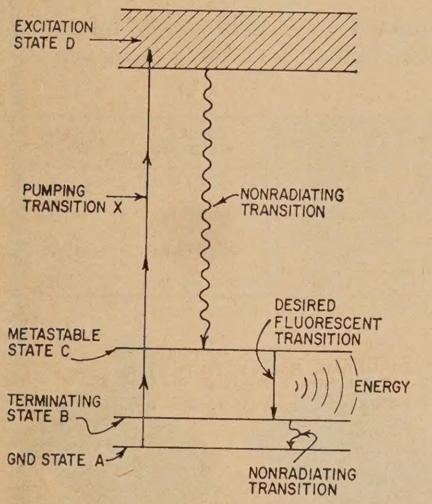
new Patents

Optical Maser

PATENT No. 3,130,254

Peter P. Sorokin, Chappaqua, N.Y., and Mirek J. Stevenson, Briarcliff Manor, N.Y. (Assigned to IBM Corp., New York, N.Y.)



In a maser, Ions are pumped or charged from a ground state A to an excited state D. Subsequently, there is a transistion to a metastable (intermediate or semistable) state C, during which energy is dissipated within the crystal lattice. No energy is radiated. When more ions in state C have accumulated than ones that are still in state A, there is another transition during which the ions radiate their excess energy and return to A.

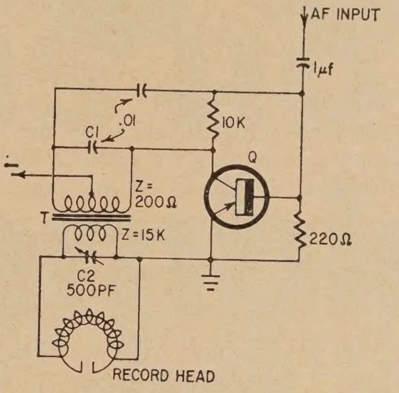
In this new maser, calcium fluoride is doped with trivalent uranium. This provides a fourth state B, between C and A. B contains few ions, so low pumping power can keep C supplied with sufficient ions for the transition to B. Cooling the maser (below liquid nitrogen temperature) depletes the supply of ions in B and lowers pumping requirements still further.

This maser is pumped by visible (green) light, a convenient advantage. Output is at 2.5 microns, which is infrared.

Tape Recording Circuit

PATENT No. 3,133,160

Kenneth A. Catto, Beaverton, Ore. (Assigned to Code-A-Phone Electronics, Inc., Seattle, Wash.)



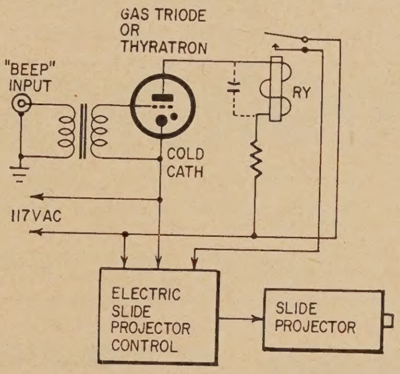
This is a combination bias oscillator, mixer and recording amplifier. The audio to be recorded on tape is fed to Q. The transistor oscillates at about 30 kc, as determined by the primary of T and capacitor C1.

The audio frequency plus the bias frequency mix in the transformer, which feeds them to the recording head. C2, a shunt capacitor, controls the amplitude of the bias voltage.

Automatic Slide Projection

PATENT No. 3,110,216

Norman L. Chalfin, 460 San Juan Place, Pasadena, Calif.



This device automatically changes slides at the appropriate moment. It uses a two-track tape recorder. One track contains the commentary for the slides. The other contains "beeps" which cause the slides to change. The same apparatus is used to record the beeps on the tape.

The diagram shows a suggested control circuit using a 0A4-G thyratron, but a silicon controlled rectifier may be used instead. The recorded beep signals are stepped up to a voltage high enough to fire the tube. When the relay closes, it actuates the projector to change the slide. END

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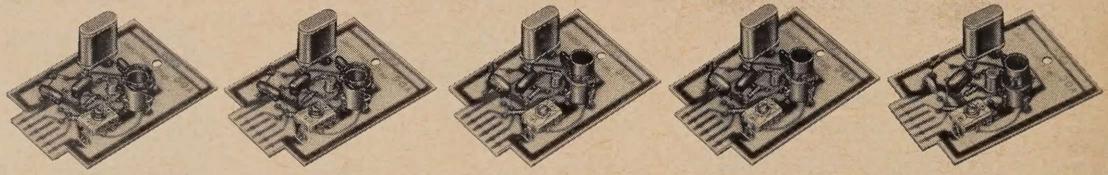

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OT-140	100-140 mc	CY-7T	±.0035%	15.00
OT-160	110-160 mc	CY-7T	±.0035%	15.00

CRYSTAL FREQUENCY	CRYSTAL PRICE
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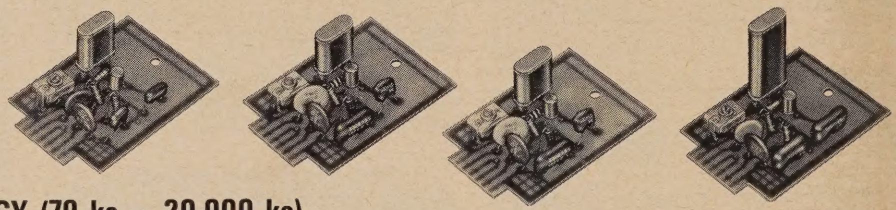
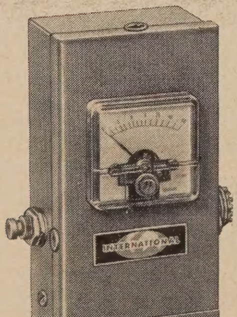


LOW FREQUENCY (70 kc — 20,000 kc)

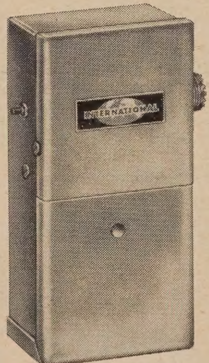
Four transistor oscillators covering 70 kc - 20,000 kc. Trimmer capacitor for zeroing crystal. When oscillator is ordered with crystal the standard will be ± .0025%. Oscillator output is 1 volt (min) across 470 ohms. Power requirement: 9 vdc @ 10 ma. max.

OSCILLATOR TYPE	OSCILLATOR RANGE	CRYSTAL TYPE	TEMPERATURE TOL. —40°F TO + 150°F	OSCILLATOR (LESS CRYSTAL) PRICE
OT-1	70-200 kc	CY-13T	±.015%	$7.00
OT-2	200-5,000 kc	CY-6T	200-600kc ±.01% 600-5,000kc ±.0035%	7.00 7.00
OT-3	2,000-12,000 kc	CY-6T	±.0035%	7.00
OT-4	10,000-20,000 kc	CY-6T	±.0035%	7.00

CRYSTAL FREQUENCY	CRYSTAL PRICE
70-99 kc	$22.50
100-200 kc	15.00
200-499 kc	12.50
500-849 kc	22.50
850-999 kc	15.00
1,000-1,499 kc	9.80
1,500-2,999 kc	6.90
3,000-10,999 kc	4.90
11,000-20,000 kc	6.90



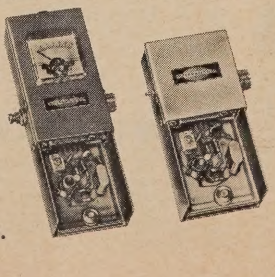
FOT-20



FOT-10

AOC OSCILLATOR CASES

Small portable cases for use with the OT series of plug-in oscillators. Prices do not include oscillators. (When oscillator and crystal are ordered with FOT-10 case a 77° F tolerance of ±.001% may be obtained at $2.00 extra per oscillator/crystal unit. When oscillator/crystal units are ordered with FOT-20 case, a single unit can be supplied with temperature calibration over a range of 40° F to 120° F. Correction to ±.0005%. Add $25.00 to the price of FOT-20 and oscillator/crystal unit.)



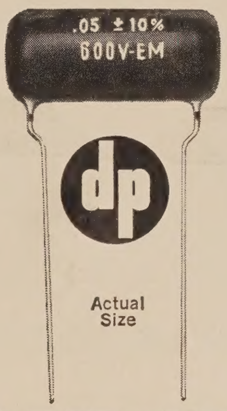
FOT-20 For high accuracy calibration requirements. Includes battery and output jack, output meter circuit and battery check, as well as thermistor temperature measuring circuit. **$87.50**

FOT-10 Basic case with battery and output jack for general wider tolerance applications. **$14.50**

MT-1 Oscillator board mounting kit. **$4.95**

Order direct from International Crystal Mfg. Co.

Quality is no gamble!



Actual Size

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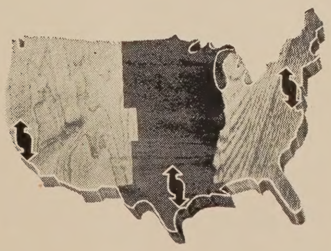
*Reg. Du Pont Trademark



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mpletely clean and given a series of chemical baths internally to
store them to the peak of their optical capabilities.

A produces and develops its own screen phosphors. These are formed by reacting solutions of zinc sulfate and zinc and cadmium sulfates with hydrogen-sulfide gas in this complex precipitator, (above). The resulting zinc sulfide and zinc-cadmium sulfide are then activated, fluxed, fired, washed, dried, and screened to form phosphors which emit blue and yellow light, respectively. These are carefully blended to produce phosphors that possess the pleasing "white", high light output, and uniform smoothness, which characterize RCA Silverama picture tube screens.

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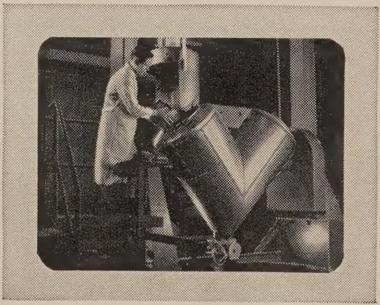
Drying ovens remove moisture from phosphor



Phosphors are blended for best screen quality

Base materials are fired to form the phosphors

61539

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